The Response of Graduate Enrollment to Placement Opportunities

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The earliest recognized case of a downturn in the expanding opportunities for new Ph.D.'s was physics. It is in this field that there has been the longest time in which to observe any adjustments that follow upon knowledge of lessened opportunity associated with getting a Ph.D. Not only does physics provide the longest record of adjustment, but it also provides the most comprehensive data of any field. The American Institute of Physics has for years kept detailed records of graduate and undergraduate enrollments, degrees granted, and many other useful bits of information. Table 1, eighth in an annual series of tables, has several noteworthy features. First, since 1967–68, the number of undergraduate physics majors enrolled as juniors has fallen year by year without interruption. The pattern of decreasing senior-year enrollments begins with that same class in 1968–69. Another striking fact can be derived from the table: beginning in 1967–68, there is a decline in the ratio of the number of first-year graduate students to the number of students granted bachelor's degrees in the previous year. The 4010 first-year graduate students of 1967–68 correspond to the 5236 students who received the bachelor's degree in 1966–67 (the fraction is 0.766). The details for 1966–67 and succeeding years are shown in Table 2. The fraction has dropped steadily from 0.766 to 0.580 in the graduate enrollments for 1971–72. These figures do not show that a perceived reduction in opportunity in physics has caused the drop, but they certainly are strongly suggestive of that causation.

From the data in Table 1, one can arrive at more than these two findings (the drop in undergraduate enrollments and the drop in the percentage of students going beyond the bachelor's degree); one can undertake, with some hazard, to answer questions such as "What will be the anticipated number of Ph.D.'s in physics in 1975? or 1980?" Such projections have been made before, but from older data and from data of a less detailed structure (more aggregated). Earlier studies also used methods applicable to disciplines (other than physics) where less information is available.

Table 3 constructs certain indices from the data in Table 1. The column headed "Juniors" is merely copied from Table 1. Column I shows the fraction of junior students in the indicated year who went on in the next year to be seniors. The number 0.897 for the year 1967–68 was derived by observing that the 7822 juniors of 1967–68 correspond to 7019 seniors in the following year (see Table 1). Similarly, Column II gives the transition rate from seniors in the indicated year to the first-year graduate students in the following year. For example, 0.547 is the fraction that results from dividing 3669 (first-year graduate students in 1968–69) by 6704 (seniors in 1967–68) (see Table 1). Column III shows the number of Ph.D.'s in the indicated year, exhibited as a fraction of the first-year graduate students 4 years before. For example, the top value in column III, 0.326, is obtained by dividing 1325 (Ph.D.'s in 1967–68) by 4061 (first-year graduate students in 1963–64) (see Table 1). This stepping back 4 years corresponds to a model of a 5-year Ph.D. in physics. That is, if one took master's degrees granted as a fraction of first-year graduate enrollments in the same academic year, one would be dealing with a 1-year program, and going an additional 4 years allows one to deal with a 5-year program.

Now that Table 3 has been derived, an estimate of the Ph.D.'s to be awarded in 1975 can be formed. On the model of a 5-year Ph.D., those future Ph.D.'s were first-year graduate students in the academic year 1970–71 [there were 3494 first-year graduate students that year (Table 1)]. If one knew the value in column III (Table 3) for the academic year 1974–75, he could multiply 3494 by that value to find the number of Ph.D.'s. Unfortunately, the 1974–75 value for column III must be estimated. I have assumed that that value will increase, noting that, among the four obtained values, the average rise per year from 0.326 to 0.368 was 0.014. By projecting that same increase for the next 5 academic years, I get the value 0.424. Applying that factor to 3494, I find the projected number of Ph.D.'s in 1974–75 to be 1480. There are two things to mention about this estimate. First, it is more likely to be too high than too low because it is based upon a very substantial projected increase in the percentage of first-year graduate students completing the Ph.D. in 5 years. Second, regardless of its probably positive bias, it is notably smaller than other extant estimates. Cartter's estimate is 1997, and he notes that the National Research Council estimate is 2383 and the Office of Education estimate is 2253 (*1*).

To project the physics Ph.D. crop in 1980 is a more hazardous undertaking, for now one is not dealing with students who are already graduate students. I begin by noting that the Ph.D.'s of 1979–80 are the first-year graduate students of 1975–76 and the juniors of 1973–74. But it is not yet known how many juniors there will be in 1973–74. In the column headed "Juniors" in Table 3, I project 2 years into the future, and the projection of 6000 juniors in physics in 1973–74 seems reasonable. I project that, in that year, the fraction of them who will continue as physics majors in the next year will be 0.90. This leads to 5400 seniors in 1974–75. To project a fraction of those putative seniors who will then go on to be first-year graduate students is the next step. I have projected 0.50 for that fraction; I have little confidence that it is the best possible projected value. The number could rise if B.S. graduates from earlier years turn to graduate study after an absence of a year or more. It could fall if disaffection with graduate study in physics increases. Therefore, I postulate two subjective bounds for the number: a high of 0.67, which is equal to its high in recent history (0.669 in 1966–67), and a low of 0.37, chosen because it would

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Table 1. Physics enrollments and degrees in the United States (10-year trend). [Source: American Institute of Physics, publication No. R-151.8, February 1971]

Academic year	Degrees granted			Undergraduate majors		Graduate students	
	B.S.	M.S.	Ph.D.	Juniors	Seniors	Total	First-year
1961–62	5,622	1,431	699	7,934	6,633	11,305	
1962–63	5,452	1,850	858	7,873	6,386	12,265	
1963–64	5,611	1,907	792	7,520	6,676	13,046	4,061
1964–65	5,517	2,045	983	7,132	6,514	13,629	4,167
1965–66	5,037	2,050	948	7,014	6,296	14,876	4,358
1966–67	5,236	2,193	1,233	7,345	5,992	15,504	4,162
1967–68	5,522	2,077	1,325	7,822	6,704	15,305	4,010
1968–69	5,975	2,223	1,355	7,587	7,019	15,475	3,669
1969–70	5,782	2,268	1,545	7,480	6,700	14,372	3,918
1970–71	5,755*	2,300*	1,530*	6,884	6,663	14,327	3,494
1971–72				6,593*	6,160*	13,276*	3,336*

* These most recent figures were supplied by Susanne Ellis, director of manpower, American Institute of Physics.

be a direct continuation of the drop of the previous 4 years in a geometric sense.

Thus far, I have carried my projection from 6000 juniors to 5400 seniors to 2700 first-year graduate students in 1974–75 (with a low estimate of 1998 and a high estimate of 3618). To carry these forward from first-year graduate students to Ph.D.'s in the year 1979–80 requires a projected value for column III; here, still more uncertainty obtains. The transition from first-year graduate student to Ph.D. in physics 4 years later is affected not only by the persistence of students in the Ph.D. track, but by the return of graduate students who have dropped out and by the relative mix of entering first-year graduate students who consider themselves candidates for master's degrees only and those who consider themselves Ph.D. candidates. I have taken as my primary estimate 0.438 (which, as already remarked, may be too large); I also give lower and upper subjective values of 0.32 (approximating the lowest observed value) and 0.50 (which seems safely and unrealistically high). Application of these three values leads to nine possibilities, of which I show (i) the primary estimate $2700 \times 0.438 = 1183$, (ii) a lowest estimate of 640, and (iii) a highest estimate of 1809. These estimates, of which 1183 is the primary one, should be compared with the National Research Council estimate of 3708, the Office of Education estimate of 2608, and the Cartter estimate of 2680 (*1*). Why are these earlier estimates so much higher? All of these projections are based on the assumption that present trends would continue into the future for another 5 or 10 years. Using more current and more detailed data, I arrive at sharply different projections of what to expect in 1975 and in 1980, based more nearly on what has happened in the last 2 to 4 years and using disaggregated data for the single field of physics.

What do my projections mean? I consider that they support the following two theses: first, that marked reduction in numbers of entrants to graduate study powerfully readjusts the size of the Ph.D. crop; second, that, perceiving the adverse economic prospects, many fewer qualified students go into physics. The first thesis is simply a mathematical one. The second cannot be proved by data such as those presented here; they may support it and make it more plausible, but they cannot do more. On the other hand, the second thesis is very plausible. It is generally believed that the influx of students into graduate study was largely and effectively stimulated by economic incentives, by the knowledge that a good career for a Ph.D. was nearly a sure thing. It is also generally believed that relatively small, short-range financial incentives such as fellowships and assistantships were powerful inducements to enter graduate study. If one believes that financial incentives affect the size of graduate enrollments, it is hard to see how one can deny the effect of financial disincentives. Therefore, I interpret the decline in numbers of undergraduate physics majors and the decline in the percentage of those going on to become graduate students as deriving from the perception of adverse placement opportunities. This interpretation overlooks the extent to which reduced entrance into graduate study may result from reduced support for graduate study—nor can the data in hand separate the two effects.

Table 2. Transition of physics bachelor's students into graduate study. (Abbreviations: t, academic year; G_1, first-year graduate students.)

Academic year	B.S. degrees awarded (t) (No.)	G_1 (t) (No.)	Fraction (t) [G_1 (t)/ B.S. (t − 1)]
1966–67	5236		
1967–68	5522	4010	0.766
1968–69	5975	3669	0.664
1969–70	5782	3918	0.656
1970–71	5755	3494	0.604
1971–72		3336	0.580

The General Case

When one leaves a consideration of physics and considers graduate study in general, one loses the certainty of good data and a well-defined field. But I argue that two features carry over. First, there is, at present rates of output, a large and substantial excess of supply over demand for Ph.D.'s and, second, a major consequence in adjusting to this excess will be a reduction of entrants into a Ph.D. course of study. Neither of these propositions is self-evident, and I now offer some justification for each.

In 1970, 27,000 Ph.D.'s were granted in the United States. In the same year,

Table 3. Projections used in estimating future Ph.D.'s in physics. [Numbers in parentheses are projections. Abbreviations: J(t), number of juniors in academic year t; S (t + 1), number of seniors in academic year t + 1; G_1 (t + 1), number of first-year graduate students in academic year t + 1; G_1 (t − 4), number of first-year graduate students in academic year t − 4; Ph.D. (t), number of Ph.D. degrees awarded in academic year t.]

Academic year	Juniors (t) (No.)	I J (t) → S (t + 1)	II S (t) → G_1 (t + 1)	III G_1 (t − 4) → Ph.D. (t)
1967–68	7822	0.897	0.547	0.326
1968–69	7587	0.883	0.558	0.325
1969–70	7480	0.891	0.521	0.355
1970–71	6884	0.895	0.501	0.368
1971–72	6593			(0.382)*
1972–73				(0.396)*
1973–74	(6000)	(0.90)		(0.410)*
1974–75			(0.50)†	(0.424)*
1975–76				(0.438)*

* These values were arrived at by adding 0.014 to the value for the year before, since that is the average annual change in the previous part of the series. Its high is 0.50, and its low 0.32. † This value gets a low of 0.37 and a high of 0.67 because a 4-year change, 0.67 to 0.50, was once observed in this series. In fact, for 1966–67, the value was 0.669.

there were 8,400 new physicians, 3,700 new dentists, and 15,200 new lawyers. It seems a matter of grave doubt that the United States now needs and will continue to need each year as many new Ph.D.'s as it needs new doctors, lawyers, and dentists combined. A second way of examining the question of whether the present size of the Ph.D. crop is unnecessarily large is to consider the matter in equilibrium. For a quarter of a century, there have been approximately 4 million births per year in the United States (and something like 99 percent of those born live to age 30). If each annual crop of 4 million is to yield 30,000 Ph.D.'s, then in the long run we shall have one Ph.D. for every 133 people. This figure should be compared with one M.D. for every 600 people in the United States. It seems unlikely that we shall need four or five times as many Ph.D.'s as M.D.'s. (One is given further pause by the fact that entrants into the medical profession in the Soviet Union number 35,000 annually, which would correspond to something like 25,000 to 30,000 in the United States.)

Although I shall continue to assume that the present intake and output from our Ph.D. training enterprise is substantially too large for the national demand, I should remark that there are opposing opinions and some countervailing factors. First, there are developing now new fields that will require highly trained manpower, and these fields will call for some kinds of Ph.D.'s not now being trained. Therefore, some transfer from existing fields into the new fields will tend to offset the present excess. Second, it may be that eligibility for certain kinds of employment will change; eventually, employment as a teacher in a junior college or even a high school may require a Ph.D. If one holds to this view strongly enough, he may conclude that automobile mechanics will eventually need master's degrees as entrance credentials. I do not know how to weigh this claim, but it is sometimes argued forcefully. Finally, we should bear in mind that forecasts that we are producing too many Ph.D.'s are of great antiquity, reaching back to the turn of the century (*2*); that knowledge may commend some reserve about making the same claim today. Despite these indications to the contrary, I continue to assume that the present Ph.D. enterprise is substantially too large for the demand of the present and of the next 20 years or so.

The mere perception of oversupply should result in a reduction of entrants into Ph.D. training, if entrance is sensitive to (perceived) economic disincentives. There is already evidence that just this kind of adjustment is in progress. The Council of Graduate Schools' annual survey of graduate enrollments (*3*) showed a 7 percent increase in graduate enrollments from autumn 1968 to autumn 1969, another 8 percent increase from autumn 1969 to autumn 1970, but only a 1 percent increase from autumn 1970 to autumn 1971. Further, the increase of enrollments in the graduate schools that offered only master's degrees was, in 1971, 9 percent, while in private universities offering the Ph.D. the total graduate enrollment actually declined by 1.5 percent. Here there is at least evidence of a tapering off of enrollment, probably of actual decline. Moreover, a leveling of *total* enrollment can easily attest to an actual reduction in *entering* enrollment in cases where there has been a recent history of increasing enrollment.

I have already examined the case of physics.

To take a peek at the future—that is, at next year's entering crop—one can turn to the students who are now taking Graduate Record Examinations. The history of this sequence of data is one of expansion. In 1968–69, there were 105,000 such examinees; in 1969–70, 138,000; in 1970–71, 147,000. There are no data for 1971–72 yet, but there are data for the first four administrations of the advanced exams in 1971–72. Those first four administrations have attracted 90,450 examinees, down 2.6 percent from the first four administrations of the previous year, which attracted 92,850. The decline exceeds 10 percent in the fields of engineering, French, and history. The only field in which there is an increase of 10 percent or more is psychology. Here, then, is another indication that there are fewer entrants into Ph.D. programs (*4*).

One may naturally ask whether departure from some fields is simply to be offset by entrance into others. In Sweden, for example, total university enrollment (which in 1969 was 115,000) diminished in 1971–72 by 10,000 from the year before, and the reason ascribed is lack of opportunity for graduates of the universities. Therefore, at least in Sweden, withdrawal from all forms of advanced study can be observed in response to economic disincentives (*5*).

All of the foregoing arguments together do not establish the fact that there will be reductions in graduate enrollments for the Ph.D. as a result of the postulated oversupply of Ph.D.'s, but they do support that thesis strongly, and I proceed as if it were true.

This thesis raises several important questions. First, which students will elect not to enter Ph.D. programs—the more capable or the less capable? Will the average level of intellectual quality of those who come be higher or lower than before? Little more can be said with confidence than that the rare student who is keenly and strongly gripped by interest in some graduate field will not be deterred by economic disincentives. Another question relates to what will happen with the "bulge." At Stanford, for example, with Ph.D. output at its all-time high and likely to stay there for another year or so, admissions into Ph.D. programs in the last few years have been the lowest in decades. Thus, despite the current cutback in Ph.D. admissions, there will be a bulge in the number of new Ph.D.'s. This will be true for all universities when cutbacks in admissions begin, as may have already occurred. This is certainly regarded as the key problem in physics at the present time.

To what extent will newly recognized societal problems call for new Ph.D. programs? Problems of ecology, transportation, crime, and health all call for trained manpower, but until substantial appropriations are made for solving these problems, there is no basis for counting on them as increasing the demand for Ph.D.'s. When scores of billions of dollars were put into the space program, thousands of engineers needed to be trained for the projects. When the higher education effort was multiplied two- or threefold, many new Ph.D.'s were required to staff it. Until some comparably massive public programs are mounted in these problem areas, they should not be considered as having any effect on the demand for Ph.D.'s.

Another question that follows upon the suggested reduction in graduate enrollments is, "Which schools will feel the reductions in numbers?" The same disincentives that are presumed to reduce graduate enrollments should operate selectively to impose relatively greater reductions on doctoral programs in fields where there is the least likelihood of employment. This then would be favorable to the well-established programs with good reputations in a given field and disadvantageous to newer, smaller, less well known programs.

Institutional Accommodations

What would be *desirable* responses to the impending cessation of growth and the probable absolute downturn in the size of Ph.D. programs on the national scale? First, it is to be hoped that every truly outstanding student who is driven by a strong desire to realize his potential in a field will have the opportunity to do so without his way being barred by financial or administrative obstacles. I believe that very deep cuts in enrollment and financial aid would have to come to pass before that desideratum were seriously threatened. Second, the presumption against establishing a new Ph.D. program in an existing field is almost overwhelming. Third, every institution now offering graduate training in several standard fields should examine itself carefully and ask such questions as, "In which of these fields is it appropriate that we actually withdraw because of inadequate library resources, or inadequate equipment resources, or misfortune with graduate placement, or merely because our institutional resources are best concentrated in some other areas that are also feeling the pinch but that are more likely to justify concentrated effort?" For any department that is to continue, it should be determined to what extent enrollment can be cut. Most departments, even the very best, have included some students who were there primarily in response to the need for trained manpower in the past decade and who, for that reason, should not be there in coming years. Pruning of such admissions is now in order. There is such a thing as cutting graduate enrollment back so far that the size of the graduate student population gets below the critical mass for effective education and training. That is a hard quantity to determine, and it differs from discipline to discipline—probably from department to department within the same discipline. If cuts need to go deeper than that, the stratagem of admitting classes, each of an adequate size, in alternate years can be considered.

This may be appropriate even now in some subdisciplines—for example, in particular areas of history. With reduced graduate enrollments, departments will do well to consider alternative ways of conducting their graduate programs. In some disciplines, it is routine to offer the advanced courses in alternate years. This simple expedient is widely employed in some departments, but appears to be utterly unknown to others. Possibly, some disciplines can make greater use of apprentice-type training than they have heretofore. Reduction in the demand for Ph.D.'s in many fields should not prevent efforts to develop new programs when the need for them becomes obvious. In establishing such new programs, a cautious eye should be kept on the adequacy of library needs, equipment needs, faculty strength, and placement opportunities.

Instead of continuing to investigate what would be desirable in the way of institutional accommodations to reduced graduate enrollment, I now try to forecast what is likely to happen. In the main, it is likely that the processes that will actually occur will resemble those described as desirable. These are some indications that the major and more prominent programs may be facing up to the needs of this era more rapidly than the less well known. For example, Koch (*6*) reports that in a survey of 134 physics departments granting the Ph.D., the admissions in 1970 dropped 17 percent below those in 1969, but that the drop was 30 percent among the 15 largest institutions. It is likely that the course of adjustment will be marred by some serious cases of shortsighted enthusiasm, local pride, and so forth, but where inferior programs are maintained against the trend, I believe the operations of the marketplace will eliminate them, although uncomfortably late. The course of accommodation will also, unfortunately, be marred from time to time by arbitrary actions of legislatures, boards of trustees, and governmental agencies overreacting to a situation that requires adjustment, not amputation. A better correspondence between what is desirable and what actually takes place will be possible if actions can be informed by reliable information.

The Data Problem

Two things are striking about the projections of physics Ph.D.'s for 1975 and 1980—first, the wealth of comprehensive data available, because of the efforts of the American Institute of Physics, and, second, the way in which those data lead to answers quite different from those obtained by examining data of a more aggregated and less adequate nature (which is true in every discipline except physics). There is a clear moral: There should be data of the same kind for graduate study as a whole. Physics is responsible for about 5 percent of Ph.D.'s. To acquire and maintain the same kind of series of data as those in Table 1 for all disciplines, or for perhaps 20 major, bellwether fields, would be a large undertaking; yet it would require perhaps only two or three times as great an effort as is now put forth by the American Institute of Physics, which must deal with 134 institutions. To solve the whole problem would involve dealing with perhaps 300 institutions. In each case, inquiries would have to be made of the dean of graduate studies. Some agencies, such as the Office of Education or the Council of Graduate Schools, should assume this task. It will require funding, but, when one considers the value of the data in aiding sensible adjustments of the multibillion dollar graduate enterprise, one should stop worrying about whether or not to do it, and look instead at how to do it.

A part of the value of physics data lies in its continuity. To begin acquiring data for 1971–72 without getting past data as well would relegate the utility of the project to some time in the future; however, most graduate schools should be able to furnish exactly the kind of data appearing in Table 1, field by field, for a period of 5 or 10 years into the past. The enterprise should also include the medical schools and the law schools. With such data available, it would be possible to guide the difficult adjustments that must be made in the future.

Because a terminal master's degree is a rarity in physics, and because it is common in many other fields, an extension of the data-gathering enterprise in the manner I have suggested would be greatly benefited by identifying those master's degrees that are in the Ph.D. track, as separate from others. As a matter of fact, maintaining data on this basis would be beneficial to institutions in internal planning, projecting enrollments, and many other purposes.

References and Notes

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