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ABSTRACT

Current evidence on the prospective decline of the labor market for Ph.D.'s is examined. Focus is on the effects of the decline in academic hiring in the quality and quantity of scholarship and research. After an introduction to the problem, the second chapter summarizes the evidence on the impending decline, maintaining that (1) research is a public good, (2) falling university enrollments will lead to fewer jobs in academe which will harm research and scholarship (and higher education generally), (3) universities cannot respond effectively, and, therefore, (4) governmental intervention is warranted. Chapter Three considers the nature of university research as a public good. The effects of reduced academic hiring, including numbers, quality, decline in research, and loss of young scholars, are surveyed in the fourth chapter. Chapter Five evaluates the arguments concerning the inability of universities to adjust optimally to the decline. The final chapter reviews alternative interventions, such as improving admissions procedures, supporting graduate students, creating more jobs in academe, and funding more research. (Author/PHR)

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JOHN FITZGERALD KENNEDY SCHOOL OF GOVERNMENT
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ABSTRACT

The demographics of higher education over the next twenty years comprise, for most educators, a dismal prospect. In composite terms, births sharply declined after the so-called "baby boom;" therefore, cohorts of college-aged people two decades later will also decline; therefore, jobs for university teachers, especially for new hires, will decline; and this last decline may lead to unfortunate losses in scholarship and research. Since scholarship and research are classic examples of "public goods," the problem may be one that calls for action by the federal government, as well as by the universities themselves.

This train of reasoning has captured the imagination of a growing number of professors, university administrators, and foundation officials. Dramatic terms such as "Lost Generation" are used to describe those who will not enter teaching and research for a lack of jobs.

Would the likely decline in hiring, perhaps especially grave at the tenured level and in certain disciplines, have deleterious effects on research? Would the best young people avoid preparation for academic careers? Might there be a case for governmental action? For example, might it make sense for the government to subsidize (for a fixed number of years) the creation of enough new tenured positions to keep up the flow of the best young talent?

Chapter I of the report juxtaposes the "strong argument" for governmental action with a hostile Congressional attitude toward governmental action in general and toward aid to higher education and research in particular. The strong argument has four steps:

1. Research is a public good.

2. Falling university enrollments will lead to fewer jobs in academia, especially for young scholars. The result will harm research and scholarship (and higher education more broadly).

3. Universities cannot (will not, should not) respond efficiently.

4. Therefore, governmental intervention is warranted.

Chapter II attempts to summarize the evidence on the pending decline. The over-all academic labor market is important, even though our interest is in the very best scholars at the finest institutions, because the probability of obtaining academic employment is likely to affect the educational choices of the very able.

Projections of academic demand work this way. From projections of numbers of people of college age at various points in time, efforts are made to estimate enrollments. There is large uncertainty in these estimates, because participation rates vary, older age groups may increasingly enter or reenter higher education, and foreign students are growing in importance (see Figure 2, p. 9). Then, from these enroll-

ment projections, an attempt is made to calculate the total demand for faculty; from this estimate of total demand and information about the age structure of current faculty, guesses are made about the demand for new faculty members. These two steps involve many assumptions, each containing considerable uncertainty. The resulting projections are far from robust (see, for example, Figure 5, p. 19, which ignores the uncertainty represented in Figure 2). Qualitatively, higher education will probably decline in size, but enrollments should not go below the levels of the early 1970's and new hires may resemble those in the late 1950's. The number of tenured openings will be about the same as the number of new hires (see Table 3, p. 24). The dramatic declines prophesied by some analysts are (a) enormously uncertain and (b) only "dramatic" if the worst is assumed and if compared to the dramatic trebling of higher education in the 1960's. Unfortunately, disaggregated projections are currently unavailable--by field, type of position, or type of institution.

Chapter III briefly considers the nature of university research as a public good. Chapter IV, a lengthy one, considers various aspects of this question: "Suppose there is a decline in the hiring of young academicians. What would be the effects on research and teaching?"

For one thing, simply the number of people in university jobs would decline. The decline in university research output, however, would not be proportional to the decline in jobs, but much less.

Will the quality of those entering academia fall? Even from a strictly economic point of view, the most able will be proportionally more likely to continue entering academic careers; adding their stronger non-economic motivation toward academia strengthens the tendency. But in absolute rather than relative terms, too many top young people may switch fields or careers because of the impending decline in university-based jobs. So far, however, this does not seem to have taken place, based on the scant data available.

But will there not be a compensating increase in research jobs? Suppose research funding stays about the same and teaching/research jobs decline; will not new, research-oriented jobs automatically be created? Will research therefore not suffer at all? These questions are seldom addressed in current policy discussions. Indecisive arguments about the synergy between teaching and research are discussed. Regarding another related issue, the existence of scale effects of "critical mass" in university research, it appears that a decline would not hurt research by forcing departments below the critical size needed to produce first-class work.

What about the "vintage effect" (in the sense of technology rather than wine), which posits that young scholars are more productive and therefore the hiring decline would be particularly harmful? Surprisingly, recent studies enable one to conclude that younger researchers are not disproportionately productive.

Chapter IV leads one to doubt many of the arguments often taken for granted about the deleterious effects of a decline. Only one finding falls on the opposite side: that current techniques for identifying future academic stars before graduate school (or even during it) are surprisingly ineffective. Several recent studies indicate that, among the current pools of applicants, we do not know how to find the most able. Thus, large cutbacks in graduate school enrollments will tend to cut back the very able, even if they are proportionally more likely to apply.

Chapter V evaluates various arguments about the inability of universities to adjust optimally to the decline. Why is this a matter for public policy? Why doesn't the market "work?" None of the arguments is as simple and straightforward as widely presumed.

Finally, Chapter VI considers, in a very cursory manner, various governmental interventions. The idea of temporary governmental subsidies for additional tenured openings fares well compared to the others, although the mechanics of implementing it are problematic and its cost is likely to be quite high (perhaps more than $100 million per year).

In conclusion, caution is urged on this issue. It does not seem opportune now, with the empirical unknowns and the political niggardliness, to propose governmental initiatives. In two years or so, more facts and a better climate may lead to a more successful call to action. Right now the need is for a warning note, an identification of the key factual questions needing work, and a careful discussion, inevitably uncertain and value-laden, of the effects of a hypothetical decline.

CONTENTS

I.

> If I were asked what are the most important qualities a young man or woman can bring to public life and the participation in public affairs, I would say first, a sound knowledge of English composition; second, a modestly exact acquaintance with the birth rate.[1]

The demographics of higher education over the next twenty years comprise, for most educators, a dismal prospect. In composite terms, which we shall attempt in a moment to unpack, births have shown a sharp decline after the so-called "baby boom;" therefore, cohorts of college-aged people two decades later will also decline; therefore, jobs for university teachers, especially for new hires, will decline; and this last decline may lead to unfortunate losses in scholarship and research. Since scholarship and research are classic examples of "public goods," the problem may be one that calls for action by the federal government, as well as by the universities themselves.

This train of reasoning has captured the imagination of a growing number of professors, university administrators, and foundation officials. Dramatic terms such as "Lost Generation" are used to describe those who will not enter teaching and research for a lack of jobs.[2] Scientists fume over the prospect of unemployed

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[1]Daniel Patrick Moynihan, "The Most Important Decision-Making Process," Policy Review, No. 1, Summer 1977, pp. 89-90.

[2]Roy Radner and Charlotte V. Kuh, Preserving a Lost Generation: Policies to Assure a Steady Flow of Young Scholars Until the Year 2000, Carnegie Council on Policy Studies in Higher Education, processed, October 1978.

(2)

Ph.D.'s; the Nixon-era Science Indicators 1972 is even accused later of a "cover-up" of this "tragic problem."[3]

But many federal policymakers are less inclined to think the problem serious or, if serious, a federal problem. Other "businesses" besides education display cycles of boom and bust, but only occasionally is governmental action thought to be an appropriate response. Regarding Congressional attitudes toward the "public good" of federally supported university research, House Staff member John Holmfeld notes:

> In recent years, however, the pendulum has begun to swing back once again--the result of no single issue but of a pervasive sense on Capitol Hill and among the public that our money could be better spent...Some observers doubt that much current research will ever prove useful....The question is whether a large percentage of scientific research placed in the common reservoir of knowledge ever emerges again.[4]

Even research specifically applied to policy questions is questioned--even by applied researchers.[5] The "golden age" of university research in the 1950's and 1960's is now frequently viewed as an overexpansion: too much was promised, too quickly, by too many academicians. So, when university men now complain of an impending decline, it is no

[3]"A report that underplays the highly visible and personally often tragic problem of unemployment and underemployment risks the label of cover-up, the more so as the claim was made that the indicators would reflect impacts on the 'quality of life.'" Gerald Holton, The Scientific Imagination: Case Studies, Cambridge, Cambridge University Press, 1978, p. 210.

[4]John D. Holmfeld, "Dilemmas down the Road," Wilson Quarterly, Vol. II, No. 3, Summer 1978, p. 76-7.

[5]For an example among many recent works, see Laurence Lynn, ed., Knowledge and Policy, Washington, D.C., National Academy of Sciences, 1978.

wonder that many policymakers are skeptical. Is the decline real? When will it impinge? How will it affect research and teaching? Why cannot universities take the necessary steps to ameliorate the problem? If the federal government could do something to help, how could it be sure it would not create yet another self-perpetuating "temporary" measure?

In this climate, university officials must be especially hard-headed. Their description of the possible trends and the consequences should stress the unknowns and uncertainties. Hypothesized relations--for examples, between declining numbers of academic jobs and a consequent decline in the proportion of the very able entering academic careers--must be put up front and examined carefully, rather than assumed to be simple facts. Alternative policies must be outlined without oversimplifying or claiming too much. These obvious warnings are worth noting only because many current analyses seem to overlook them.

This paper examines some of the current evidence on the prospective decline on the labor market for Ph.D.'s. It focusses not on the aggregate problem of unemployment that may ensue, but on the effects of the decline in academic hires in the quantity and quality of scholarship and research.

After posing "the strong argument" for considering this issue a matter for public policy, the paper in turn examines the argument's four components:

- Basic research is a "public good," in whose production American universities play a critical role.
- The cutback in doctoral hiring will weaken basic research, through a reduction in the scientific and scholarly workforce, a decline in quality of those entering that workforce, and a lack of vigor resulting from a disproportionate lack of young scientists and scholars.
- Universities cannot (will not, should not) overcome the problem themselves (as, for example, by simply hiring more young scientists and scholars).
- Certain governmental actions could greatly ameliorate the problem, without creating new problems or foregoing too many benefits (as, the benefits of those-who-would-be-Ph.D.'s entering other socially useful occupations).

II.

> When an organization is unable to attract outstanding new participants it suffers a reduction in the input of new ideas and in the supply of future leaders. As a result, the cadre of experienced people available for promotion to the top positions in the organization may not contain the number of high quality individuals desired. The university may be forced to look outside for individuals for top professorships, for example. Thus, the probability of attaining a top post for those within the organization is reduced further, and the job of attracting bright young people into the organization is made even more difficult.[6]

The number of Americans of college age--say, those eighteen years old--is easy to predict for every year up to eighteen years hence. Beyond that point, predictions are shaky, particularly because some experts believe that many women are now postponing childbirth and that a "baby boomlet" may be on the way.[7] Figure 1 provides what can safely be predicted from known births, as well as several projections of what might happen thereafter. As an example, note that the pool of eighteen-year-olds in 1993 will be about 25 percent less than in 1975.

Undergraduate enrollments are a function of the number of eighteen-year-olds, but they also depend on other variables. Participation rates among eighteen-year-olds have varied over time; they seem to respond to economic forces such as college costs, earnings differentials, and the opportunity cost of foregone earnings while a student.[8] Experts disagree about future rates of participation.

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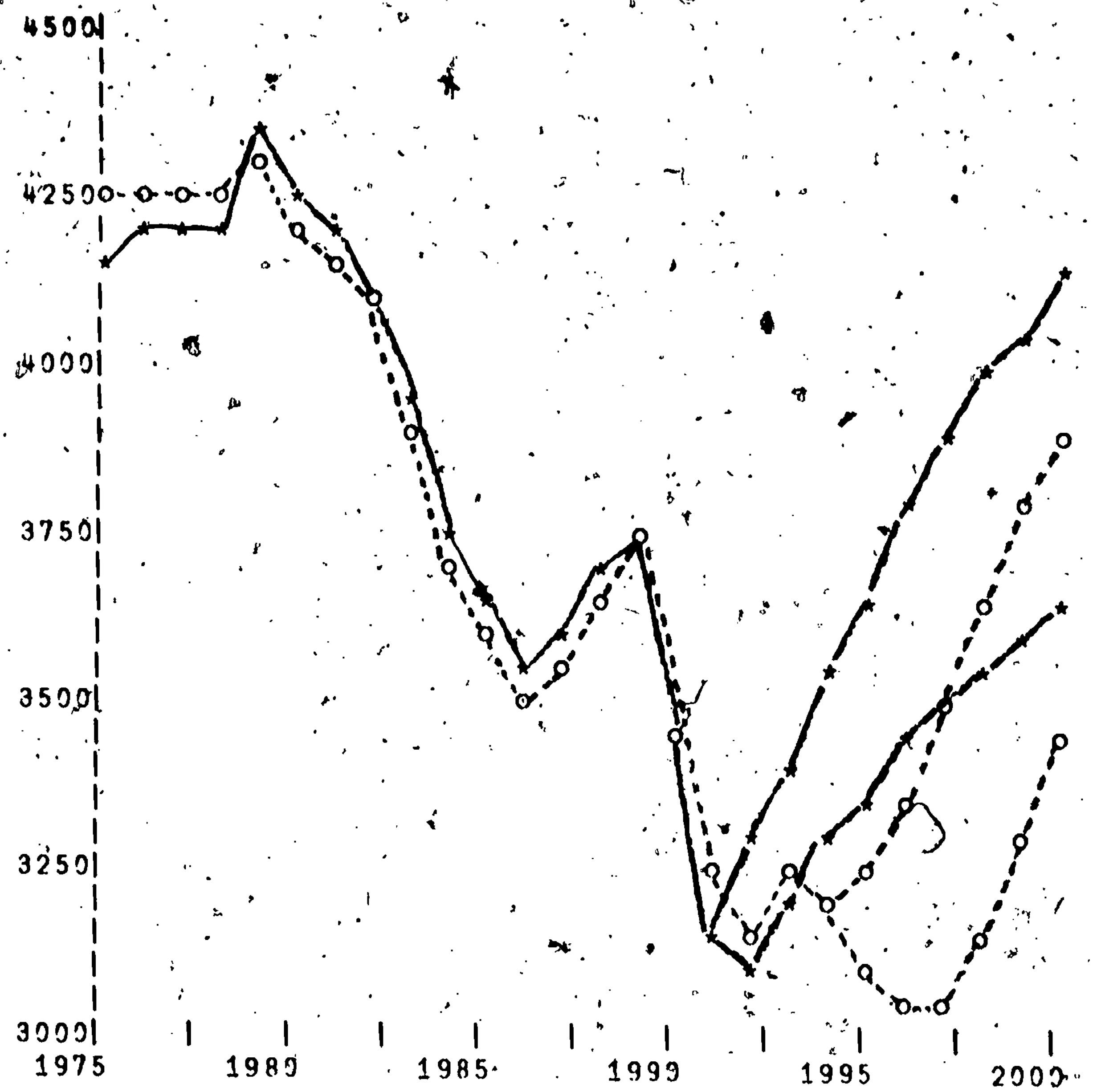
[6] Richard M. Cyert, "The Management of Universities of Constant or Decreasing Size," Public Administration Review, Vol.38, No. 4, July/August 1978, p. 345.

[7] Arthur A. Campbell, "Boom to Birth Dearth and Beyond," The Annals, Vol. 435, January 1978.

[8] For example, Richard B. Freeman, The Overeducated American, New York, Academic Press, 1976.

Figure 1. CENSUS PROJECTIONS OF EIGHTEEN-YEAR-OLDS (THOUSANDS)



* - 1973 *CENSUS PROJECTIONS*
o - 1977 *CENSUS PROJECTIONS*

Source: Fernandez, 1978, p. 12.

Bowen predicts a boom during the 1980's and 1990's due to much higher participation rates; he bases his argument on the greater importance of higher education in an increasingly "service-oriented" economy.[9] Others note a recent decline in participation rates among college-aged youths:

> The fall in enrollments from the middle and upper classes represents a major change in the traditional pattern of intergenerational mobility; for the first time, large numbers of young persons appeared likely to obtain less schooling and potentially lower occupational status than their parents.[10]

Other factors will also affect enrollment in universities. Other age groups increasingly attend college-level courses, especially on a part-time basis. Future predictions are, to my knowledge, unavailable. Foreigners are likely to become an increasingly large proportion of the college population. In 1976-77, the most recent year for which figures are available, foreign students enrolled in U.S. increased by 13 percent to a total of 203,000. In the past decade, that number has more than doubled.[11] Again, predictions of future enrollments do not seem to exist. Studies that overlook growth in these two sources of students, however, probably underestimate future enrollments.

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[9]Bowen avoids flat predictions, but argues that "the higher education industry might well double or treble in size during the balance of this century." Howard R. Bowen, "Higher Education: A Growth Industry?," Educational Record, Vol. 55, No. 3, Summer 1974, p. 157.

[10]Richard B. Freeman, The Declining Economic Value of Higher Education and the American Social System, Aspen Institute for Humanistic Seudies, 1976, p. 8.

[11]Alfred C. Julian and Robert E. Slattery, Open Doors 1975/6-1976/7, New York, Institute of International Education, 1978, pp. 5-6. According to another recent report, 256 doctorate-granting institutions in the United States enrolled more than 76,000 non-immigrant foreign students from developing countries in 1977-78 (Higher Education Panel, Scientific and Technical Cooperation with Developing Countries, 1977-78, American Council on Education, Washington, D.C., 1978.)

Allan Cartter's several projections of aggregate undergraduate enrollments are provided in Figure 2. Figure 3, provided by Roy Radner and Charlotte V. Kuh, places the decline in perspective by comparing their projection with the extraordinary growth in enrollments that took place in the 1950's and 1960's. At the lowest point, enrollment is still above any enrollment figure of 1975 or before. During the 1960's, "a 50-percent increase in less than a decade in the size of the colleges was accompanied by a more than 100-percent increase in the size of the graduate schools."[12] (In fact, between 1960 and 1970 graduate enrollment grew by 153 percent.[13]) The declining picture of most of the 1980's and 1990's is especially hard for universities after having expanded so enormously in the immediate past.

Other sorts of enrollments also affect the job market for new teachers. Figure 4 gives Cartter's "best guesses" for several kinds of enrollment figures over time.

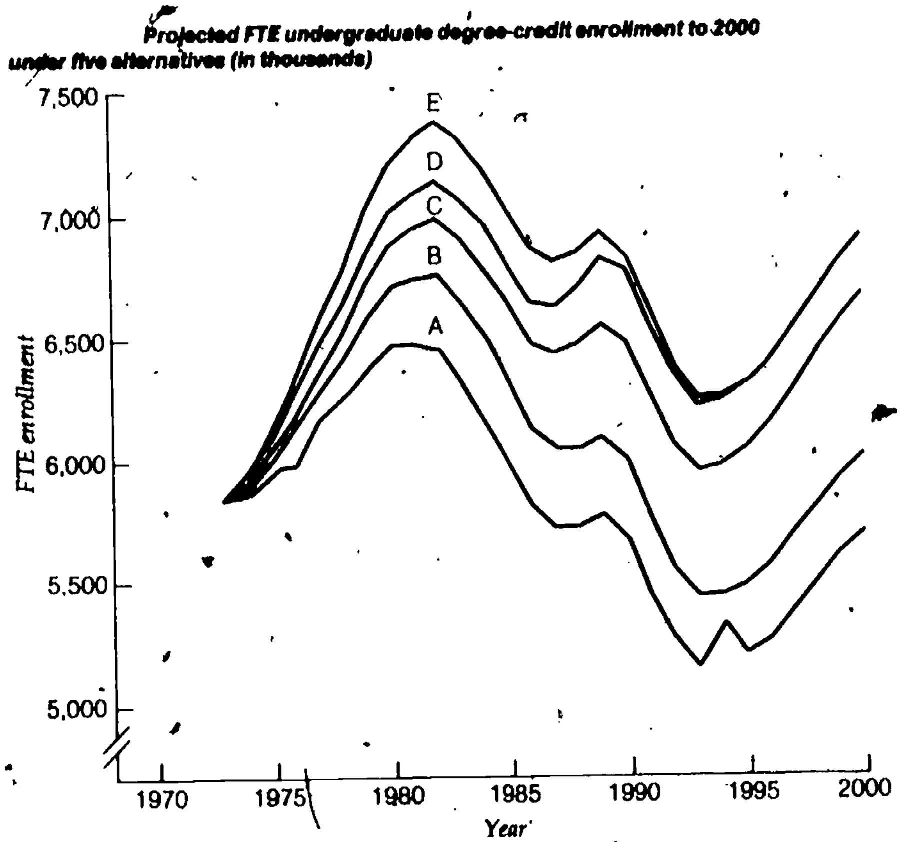
It is worth emphasizing what several experts say about the uncertainty of these projections--uncertainties that are often bypassed in quick statements of the issues, and occasionally glossed over in longer treatments. Kenneth Deitch writes:

[12]Nathan Keyfitz, "The Impending Crisis in American Graduate Schools," The Public Interest, Vol. 52, June 1978, p. 90.

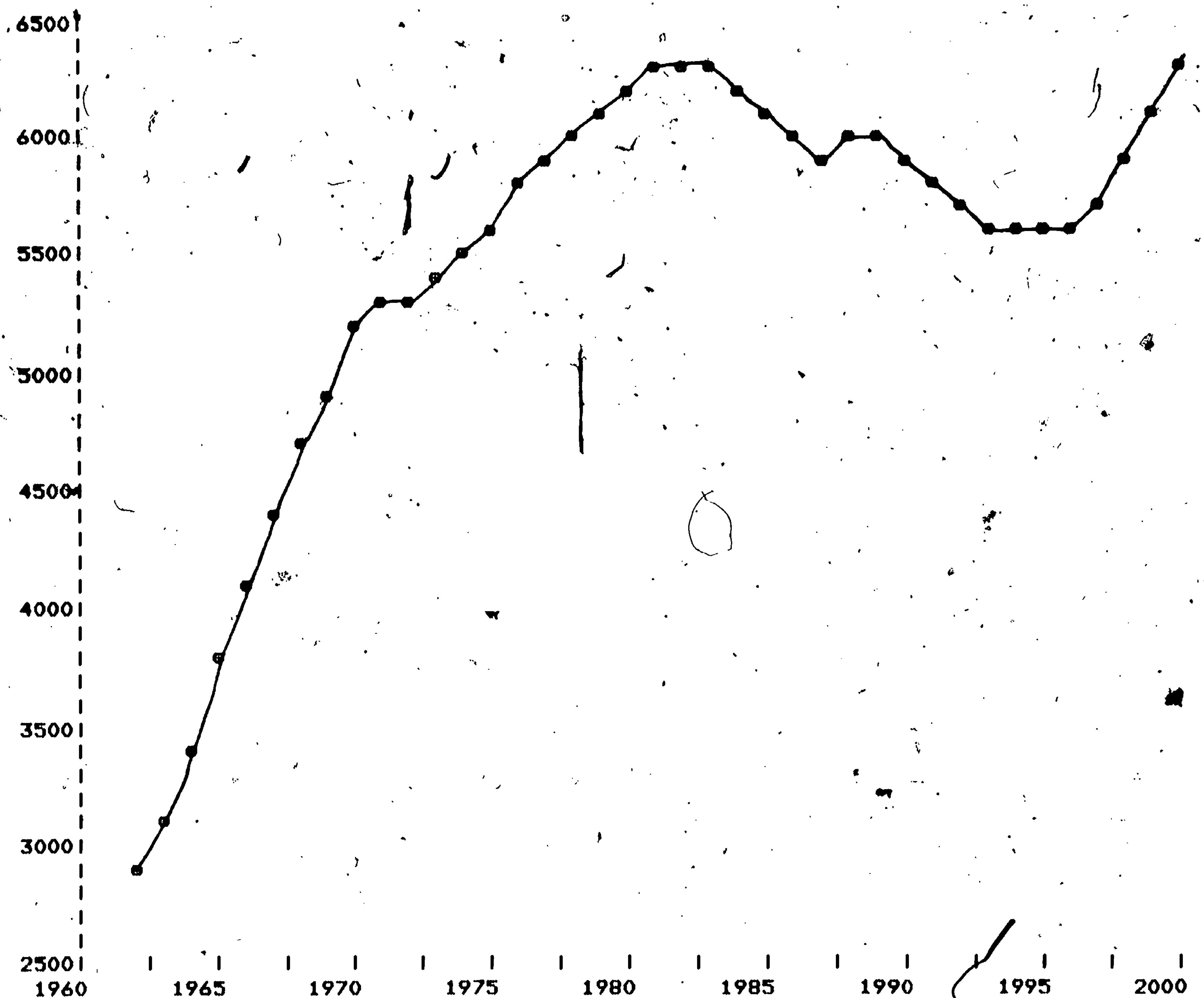
[13]Allan Cartter, Ph.D.'s and the Academic Labor Market, New York, McGraw-Hill, 1976, pp. 74-5.

Figure 2

PROJECTED FULL-TIME EQUIVALENT UNDERGRADUATE
DEGREE-CREDIT ENROLLMENT TO 2000 UNDER
FIVE ALTERNATIVES (in Thousands)
(Cartter, 1976, p. 67)



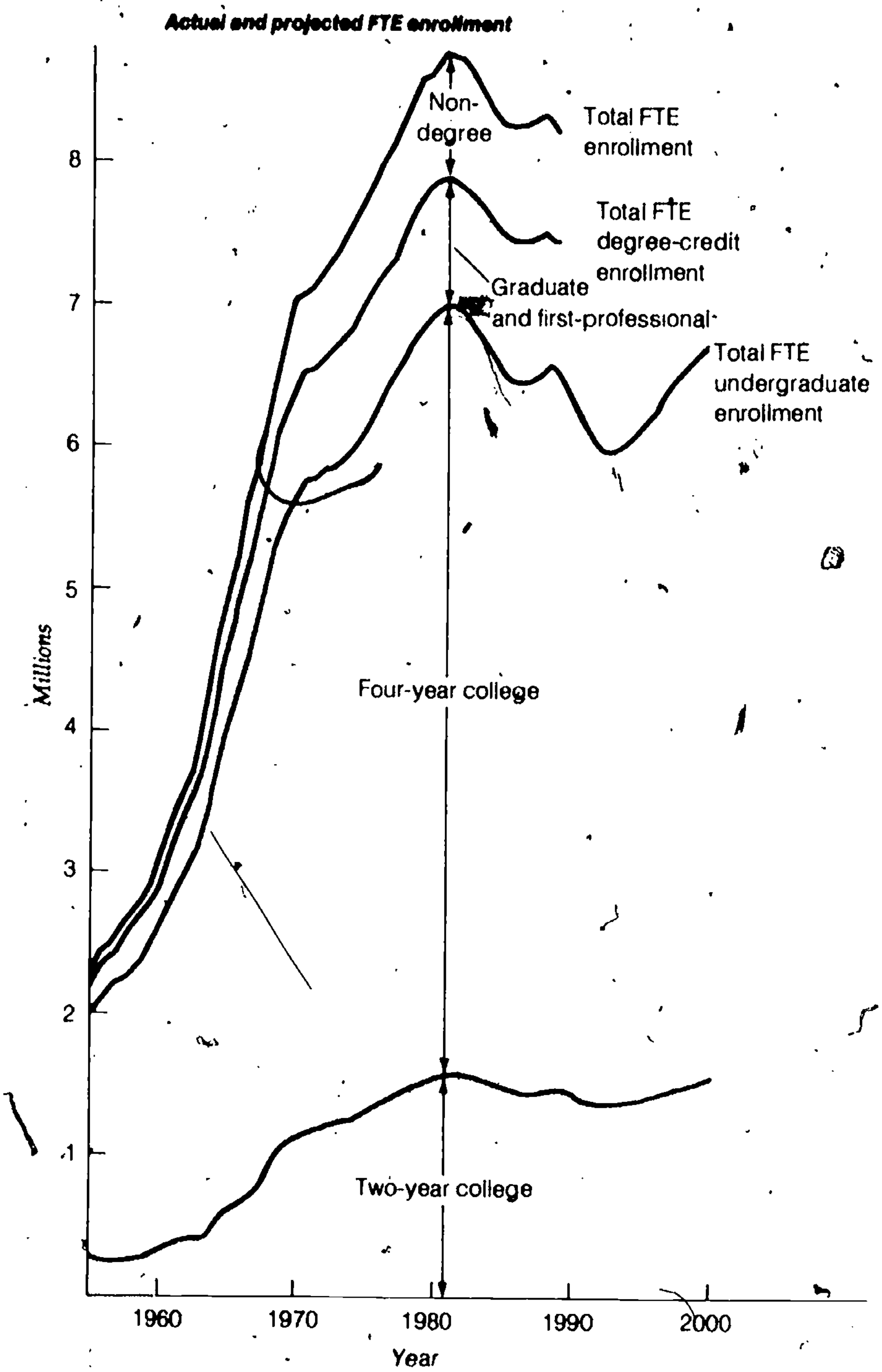
Note: Cartter said: "...the author feels at this time that C is the most likely enrollment path, that B and D are within a reasonably high probability range, and that A and E are rather unprobable extremes" (p. 65). For a description of the altneratives' assumptions, see pp. 55-7.



FTE ENROLLMENTS IN 4 YEAR INSTITUTIONS

Figure 3. A PROJECTION BY CHARLOTTE V. KUH AND ROY RADNER (KENNEDY SCHOOL SEMINAR, DECEMBER 1978)

Figure 4. CARTTER'S BEST GUESSES FOR VARIOUS TYPES OF ENROLLMENT OVER TIME



Source: Cartter, 1976, p. 91

> What is in store for enrollment? This question brings to mind the answer once given to the question, "What will the stock market do?" The answer--the only answer in which one can have great confidence--was, "It will fluctuate." Obviously no one knows for sure what will happen to enrollment. The range of possibilities receiving serious attention contains enormous variation.[14]

Professor Nathan Keyfitz declares that the expansion or contraction of higher education is "anyone's guess" (private conversation).

From Enrollments to Hiring

The uncertainties become even more pronounced when one tries to reason from enrollments to new faculty hires (and from enrollments to tenured openings). First, we shall examine some general ideas behind the linkage of enrollments to academic jobs. Then, in the context of the most recent and sophisticated aggregate projections, performed by Luis Fernandez, Charlotte V. Kuh, and Roy Radner, we shall attempt to specify the uncertainties in detail. Projections disaggregated by academic field or by type of university are extremely hard to find.

Allan Cartter, Richard Freeman, and others compare the hiring of faculty to the demand for investment goods--a "derived demand" that depends on the rate of change in enrollments.[15] The tenure system is what makes the age structure of faculty and the rate of expansion the key parameters in hiring of new faculty. Several assumptions are

[14]Kenneth M. Deitch, Some Aspects of the Economics of Higher Education, Sloan Commission on Government and Higher Education, processed, January 1978. This manuscript is extremely useful.

[15]Cartter, op. cit., p. 2; Richard B. Freeman, "The Job Market for College Faculty," Discussion Paper 596, Harvard Institute of Economic Research, December 1977, pp. 24-28.

important even in the simplest model: student/teacher ratios are constant (the usual number ratio is 17:1), the number of faculty demanded is linearly related to a single parameter called "wages," faculty retirement rates are constant and can be represented with a single parameter. Then:

Total faculty demand = (student/teacher ratio) (enrollment) - (some constant) (wages)

In symbols: $F^d = aE - bW$. New faculty demand is equal to the total faculty in time t+1 minus the total faculty in time t less the number who retired--in symbols,

$$NF^d_{t+1} = F^d_{t+1} - (1 - \lambda) F_t = aE - bW - (1 - \lambda) F_t,$$

where λ is the proportion of faculty leaving academia through retirement or otherwise. In equilibrium, $F_t = cE_t - bW_t$ and $F_{t+1} = cE_{t+1} - bW_{t+1}$, so

$$NF^D_{t+1} = a \Delta E - b \Delta W + \lambda F_t.$$

Here ΔE is the change in enrollments between the two periods. This simple accelerator model makes the demand for new faculty dependent on changes in enrollments. And this is the reasoning behind the projections of large fluctuations in new faculty hires in the 1980's and 1990's; apart from the decline, instability from year to year is projected.

Before considering some estimates of the decline and the instability, it is worth emphasizing some of the key parameters used to connect enrollment to the demand for faculty: student-faculty ratios, (relative) faculty salaries, rates for retirement and "net out-migration" from academia, the proportion of new hires that will not have Ph.D.'s, and promotion rates. Thus, on top of all the uncertainties of the enrollment projections, one now faces added uncertainties in each of the other parameters. Any single projection is misleading, even in a fairly simple aggregated model. (The effects of aggregating across all schools, all fields, and all scholars also introduces "uncertainty," as discussed later in the paper.)

Luis Fernandez has recently produced an aggregate model of the academic demand for Ph.D.'s till the year 2000.[16] Fernandez uses updated Census Bureau estimates of age cohorts (1977 Series II), along with all of Cartter's assumptions about factors affecting enrollment among that cohort, in order to create revised enrollment estimates (pp. 14-16). Then, he varies each of the parameters mentioned in the previous paragraph, one at a time, over what he believes a "best guess" and two more extreme values. Several of his parameters, in my opinion, are not varied far enough. And he does not provide an over-all "confidence interval" that assumes all

[16] Luis Fernandez, U.S. Faculty After the Boom: Demographic Projections to 2000, Carnegie Council on Policy Studies in Higher Education, April 1978 (revised version issued November 1978), processed.

the parameters varied at once. The result is what I believe are misleadingly precise and robust estimates of aggregate demand.

Two examples of not varying the parameters enough are worth citing. First, to my surprise at least, Fernandez shows that in 1975 even at four-year colleges and universities, only about 50 percent of full-time faculty had doctorates.[17] He assumes, without supporting argument, that the highest percentage that could be reached by the year 2000 would be 65 percent (Table 2-8, p. 22); and, letting faculty-student ratios also vary, he assumes that the highest doctoral faculty-student ratio would reach only 0.036, and this by the year 2000. The current figure is about 0.031. This assumption seems too restrictive. Doctoral wages are likely to fall in the 1980's and 1990's, a time of excess supply. One might imagine that 75 to 90 percent of new hires at four-year institutions would have doctoral degrees. Data are not available to enable me to calculate the doctoral faculty-student ratio implied.

Second, Fernandez assumes too low an upper limit on what he calls "net quits"--that is, retirements plus the net flow of academics to other jobs. His high rates of net quits per year "in the peak year" (assumed to be 1986) are 0.02 for tenured faculty and 0.01 for non-tenured faculty (p. 64). For the high estimate, he assumes that quit rates will rise to that level from assumed 1975 levels of

[17] He estimates full-time faculty at four-year institutions in 1975 to have been 370,000 and the number of full-time faculty with doctorates at such institutions to have been 188,561. "Hence...the percentage of full-time faculty with doctorates is 50.5%" (p. 19)--actually, to one decimal place it is 51.0%.

0.005 and 0.02, respectively--and, questionably, that after 1986, quit rates will decline and smoothly fall back to the 1975 levels by 1995, remaining constant thereafter. Fernandez offers no support for these assumptions. Everyone may have his own opinion on this matter, but Cartter and Freeman have shown that "net quits" increase in times of a poor labor market for academics. A more useful upper bound for the lean years from the middle 1980's to the middle 1990's, it seems to me, is 0.03 for both tenured and non-tenured faculty. Cartter shows that reasonable variations in this one variable lead to projections of new hires differing by a factor of 5 or 6 by 1985 (op. cit., p. 170). Again, not having the Fernandez data tapes nor his computer programs precludes a detailed examination of changing these upper bounds.

Enormous Uncertainties

Nonetheless, using his own bounds, one can construct projections that, in my opinion, more accurately reflect the uncertainties. Tables 1 and 2 and Figure 5 provide a crude depiction of upper and lower bounds on new hires--crude not least because they do not take into account the uncertainty in enrollment projections alluded to earlier.

In constructing Figure 5, I have aggregated the individual effects of the variation in Fernandez' parameters, using his choice for "high" and "low" values for each variable. One aggregation was done by crudely assuming that the individual percentage effects of moving each variable to its high or low value may occur simultaneously. This assumes that the percentage effect of different quit rates does not

Table 1

PERCENTAGE CHANGES IN NEW DOCTORAL HIRES UNDER FERNANDEZ' VARIOUS "HIGH" AND "LOW" ASSUMPTIONS

	"Low" (-X%)						"High" (+X%)				
Year	Mand. Retire.	Non-Tenured Quits	Tenured Quits	Promo. Rate	DFSR	Baseline	DFSR	Promo. Rate	Tenured Quits	Non-Tenured Quits	Mand. Retire.
1976	0	+2	1	0	8	9,300	7	0	2	8	0
	0	1	2	0	9	9,200	7	0	3	10	0
	2	4	2	0	10	9,600	8	1	5	11	1
	3	6	3	1	10	10,600	8	1	6	12	1
1980	4	9	4	1	11	10,700	8	2	8	14	2
	7	13	6	1	13	9,500	10	3	11	18	3
	7	16	7	2	14	9,300	11	4	14	21	4
	8	22	10	3	18	7,800	13	7	20	27	4
	9	26	13	5	20	7,200	15	10	24	31	4
1985	12	36	18	8	26	5,600	20	20	36	42	6
	12	33	19	10	26	5,700	20	26	36	39	6
	9	22	13	9	21	7,300	16	23	25	27	4
	8	16	10	7	18	8,900	14	20	19	20	3
	6	12	7	6	16	10,200	12	17	14	17	3
1990	11	19	10	8	23	5,800	18	26	20	28	5
	19	24	14	11	33	3,400	26	37	28	40	9
	21	15	10	10	30	3,500	23	36	20	30	10
	14	6	5	7	22	5,100	17	23	10	16	7
	10	2	2	5	18	6,500	13	16	4	10	5
1995	8	+1	0	4	17	6,000	13	15	1	9	4
	7	0	0	3	15	8,300	11	11	-2	0	3
	5	0	0	2	13	10,500	10	9	-2	0	2
	4	0	0	1	12	14,200	10	6	-2	0	2
	3	0	+1	1	13	15,000	10	5	-2	0	2
2000	3	0	+1	2	13	15,700	10	3	-2	0	2

Note: All figures have been rounded. DFSR = doctoral faculty-student ratio. Promo. rate = rate of promotion to tenure. Tenured quits = estimates of net outflows of tenured faculty through retirement or leaving academia. Non-tenured quits are defined correspondingly. Mand. retire. = estimates of the effect of different university reactions to the change in the mandatory retirement age (the "high" estimate assumes that the effective pattern of retirement is not changed from the current one). All assumptions and estimates are Fernandez'. Note that uncertainty in enrollment figures is not included here.

Table 2

COMBINED "HIGH" AND "LOW" PROJECTIONS OF NEW DOCTORAL HIRES BY FOUR-YEAR ACADEMIC INSTITUTIONS

	(Low) Additive		(Low) Multiplicative			(High) Multiplicative		(High) Additive	
	Low Estimate	Combined Low (%)	Low Estimate	Combined Low (%)	Baseline	Combined High (%)	High Estimate	Combined High (%)	High Estimate
1976	8,600	-7	8,600	-7	9,300	18	11,000	17	10,900
	8,100	-12	8,100	-12	9,200	21	11,200	20	11,000
	7,900	-18	8,000	-17	9,600	28	12,300	18	11,300
	8,200	-23	8,400	-21	10,600	31	14,000	28	13,600
1980	7,600	-29	7,900	-26	10,700	38	14,800	34	14,300
	5,700	-40	6,200	-34	9,500	53	14,500	45	13,800
	5,000	-46	5,700	-39	9,300	66	15,400	54	14,300
	3,000	-61	4,000	-49	7,800	92	14,900	71	13,300
	1,900	-73	3,200	-55	7,200	114	15,400	84	13,200
1985	0	-100	1,800	-69	5,600	195	16,500	124	12,500
	0	-100	1,800	-68	5,700	203	17,300	127	12,900
	1,900	-74	3,200	-56	7,300	136	17,200	95	14,200
	3,600	-59	4,700	-47	8,900	101	17,900	76	15,700
	5,400	-47	6,200	-39	10,200	80	18,400	63	16,600
1990	1,700	-71	2,700	-54	5,800	140	13,900	87	10,800
	0	-101	1,100	-68	3,400	237	11,500	140	8,200
	500	-86	1,300	-62	3,500	187	10,000	119	7,700
	2,300	-54	2,800	-44	5,100	96	10,000	73	8,300
	4,100	-37	4,400	-33	6,500	57	10,[illegible]0	48	9,600
1995	4,300	-28	4,400	-26	6,000	49	8,900	42	8,500
	6,200	-25	6,400	-23	8,300	24	10,300	23	10,200
	8,400	-20	8,500	-19	10,500	20	12,600	19	12,500
	11,800	-17	11,900	-16	14,200	17	16,600	16	16,500
	12,600	-16	12,700	-16	15,000	15	17,300	15	17,300
2000	12,900	-18	13,100	-16	15,700	13	17,800	13	17,800

Source: Author's computations based on Table 1. Note that uncertainty in enrollment figures is not included here.

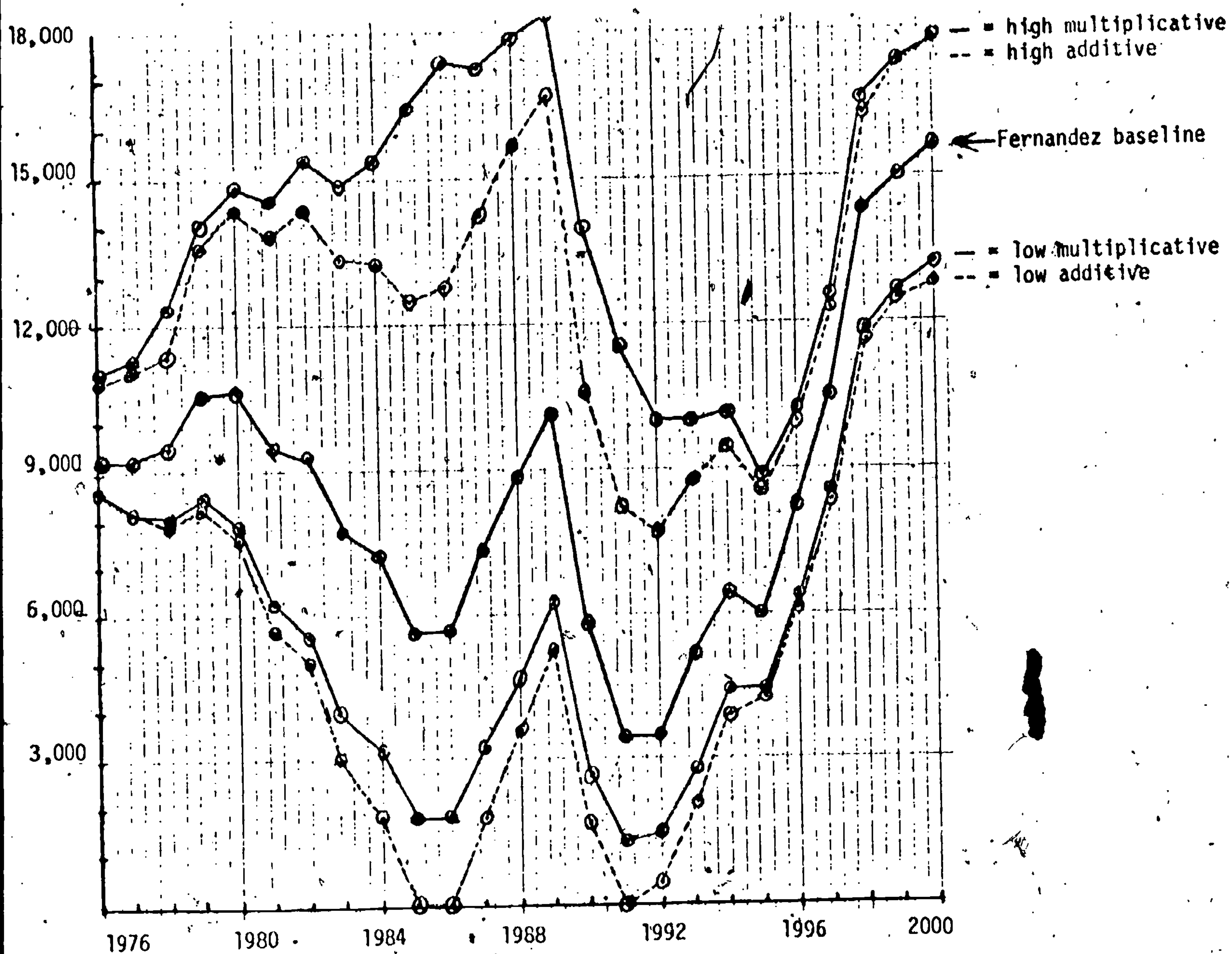


Figure 5. NEW DOCTORAL HIRES AT FOUR-YEAR INSTITUTIONS: HIGH, LOW, AND BASELINE PROJECTIONS USING FERNANDEZ' DATA

Note: The variability represented here does not include uncertainty in enrollments. Calculations and graph by author.

depend on the percentage effects of different doctoral student-faculty ratios. For example, consider 1991. If, as Fernandez posits, 28 percent more Ph.D.'s are hired when tenured faculty quit rates are "high" rather than "medium" (p. 79) and if 26 percent more Ph.D.'s are hired when the doctoral faculty-student ratio is "high" rather than "medium" (p. 38), then the effect of both being high instead of medium is assumed to be 1.28 x 1.26 = 1.61, or 61 percent more hires. Such adjustments were made for all the parameters that Fernandez varied singly, and the results are the high and low multiplicative projections.[18] Another aggregation was done by simply adding the percentage effects rather than multiplying them: these are the high and low additive projections.

Figure 5 shows more accurately than any of Fernandez's graphs just how uncertain the projections are (contrary to his claim that they are "fairly robust," p. 4). When one adds to this result the fact that this projection assumed no uncertainty in enrollment rates, one appreciates that even fairly simple, aggregate projections yield enormously different numbers. This is, I believe, an important lesson.

Problems of Aggregation

After spending this effort on an aggregated model and ascertaining its large uncertainties, it may be frustrating to the point of of depression to note that, by aggregating and by ignoring

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[18] The assumption of independence may be criticized for variables like "tenured quit rate" and "non-tenured quit rate." However, this does not necessarily affect the procedure employed here. The upper bound may still be precisely the case when both are high, and an estimate of the effect of both being high may plausibly be by aggregating the two effects in the multiplicative way described in the text. In the absence of Fernandez' detailed model, this crude aggregation of uncertainty is perhaps the best way to indicate the lack of robustness in his projections.

many market responses, the model introduces further inaccuracies and biases of unknown size. It is worth stressing a few of them.[19]

First, aggregate models like his and Cartter's group over fields. Yet, it is known that labor market conditions, on both the demand and supply sides, are dramatically different in, for example, physics and history. (More on this point below.)

Second, the model assumes that what happens in one four-year college or university is what happens in another. "Since our figures are aggregated over all four-year institutions, most institutions must be decreasing their staffs" (p. 33; strictly, Fernandez should say "all"). Fernandez admits:

> (T)here is no reason to believe that our aggregating over the diverse array of types of institutions--each with different growth patterns, age distributions of faculty, mixtures of teaching and research faculty, links with non-academic employers, concepts about tenure, preferences for new doctorate faculty versus experienced non-doctorate faculty, etc.--introduces only "second-order" error (p. 145).

More likely than uniform behavior is, say, 200 universities with no drop at all in enrollment and another 200, perhaps mostly small colleges, going out of business altogether. This alternative to an equal-sized cutback at each school has quite different implications for tenured "quit rates," faculty-student ratios,[20] time to tenure,

[19] At the beginning of Appendix 3, Fernandez says, "Once we are confident that we have done as careful and accurate job of inferring the likely consequences of a world operating as we have posited it, we can go on to the more formidable task of criticizing and amending our simplifications of reality" (p. 145). Unfortunately, the monograph never does go on to that task.

[20] Fernandez cites Radner and Miller, who showed "significant correlations between institution characteristics (i.e., the fraction of faculty with doctorates, the quality of the graduate program, and average faculty salary) and the student-faculty ratio" (p. 17; Roy Radner and Leonard S. Miller, Demand and Supply in U.S. Higher Education, New York, McGraw-Hill, 1975).

and the attractiveness to new entrants of the available jobs.

Third, the differential quality of new Ph.D.'s is ignored. As Fernandez puts it: "In the terminology of Markov theory, we are 'lumping' over quality" (p. 128). As discussed below, this strong assumption needs to be broken down before the academic effects of a hiring cutback can be evaluated.

Finally, the model assumes what seems to be rigid and short-sighted behavior on the part of colleges and universities, as well as by the pursuers of new teaching jobs. Radner and Kuh make much of the instability in the number of new hires per year, which is driven in their model and Fernandez' by fluctuations in the birth rate. They call for a federal program to smooth out the demand (as we shall see later in the paper). To obtain such fluctuations, universities must be assumed to act myopically, without regard to any estimate of next year's job openings. Universities must be assumed not to vary faculty-student ratios in response to the short-term jumps, leaving all the fluctuation on the hiring side. Ph.D. students must be assumed not to postpone or advance their degree date based on large year-to-year shifts in the market. And the term "lost generation" may incorrectly lead readers to infer that a new Ph.D. who is not hired immediately upon graduation will be lost to the academic market forever. But the person not hired in a lean year like 1986 or 1992 may simply wait another year or two, when, according to the projections, the need for new Ph.D.'s should be much greater. The result of foresight among university officials, doctoral students, and new Ph.D.'s should be a much smoother curve for new hires than Fernandez, Radner, and Kuh posit. (Insofar as much of the worry represented in Radner and Kuh's analysis pertains to fluctuations in demand, more realistic assumptions, and active steps to educate universities about year-to-year swings in enrollment, may lessen it.)[21]

Before leaving Fernandez' projections, it is worth citing his aggregate estimates of the number of tenured openings.[22] Table 3 rounds off the figures given by his baseline assumptions. Notice, too, how the probability of obtaining tenure varies over time. These are the only projections of tenured openings I could find in the published literature. It should now go without saying that they are subject to large uncertainties: retirement rates, swings in student interests, enrollment rates, and so forth.

Disaggregated Projections

Projections disaggregated by field or type of institution are rare. Several researchers are working on this problem, but I have seen no such projections to date.

[21] This observation is not weakened by the fact that, in the boom years of the 1960's, and before, hiring did show wide swings from year to year. Behavior in a decline, especially when aided by prior information about the yearly fluctuations, need not be so erratic.

[22] Fernandez, op. cit., p. 32.

Table 3

THE FLOW OF YOUNG DOCTORATES INTO THE TENURED RANKS AT FOUR-YEAR INSTITUTIONS

Year	Non-Tenured Faculty	Promotion Rate	Newly Tenured Faculty
1976	59,000	0.19	11,000
1980	50,000	0.14	7,000
1985	36,000	0.10	4,000
1990	37,000	0.12	4,000
1995	32,000	0.14	4,000
2000	61,000	0.10	6,000

Note: Figures rounded from Fernandez, op. cit., Table 2-15, p. 32.

Christoph von Rothkirch has recently completed a fixed-coefficient model disaggregated by academic area.[23] It does not, however, address the question of the market for new doctorates. What makes it worth mentioning are the difficult, perhaps inherent problems of making disaggregated projections in times of change and in the absence of sufficient data.

At the heart of his model are two assumptions: (1) First-year graduate enrollment will develop according to alternative II in Cartter's aggregated "market response model" and (2) the choice of field and rates of degree completion will "asymptotically" follow the trends effective

[23] Field Disaggregated Analysis and Projections of Graduate Enrollment and Higher Degree Production, Carnegie Council on Policy Studies in Higher Education, October 1978, processed.

from 1969 to 1975 (p. 31). Von Rothkirch is properly cautious in his confidence in such extrapolations, especially beyond the next few years. Perhaps not surprisingly, given his basic assumptions, von Rothkirch's extrapolations "confirm hypotheses already raised in global models" (p. 43), although "(d)isaggregation with respect to academic fields is especially necessary if a model is used for the evaluation of policies and the analysis of policy impacts" (p. 3). Von Rothkirch's extrapolations are not fully consistent with a market-based model, which has students select fields and complete degrees strictly according to the relative economic rewards of doing so. "As a possible explanation for these findings we already mentioned students' concern about actual problems of their physical and social environments" (p. 43): students study subjects that are academically interesting or socially useful, as well as considering profitability. "This hypothesis is, of course, to be tested by means of a disaggregated model," the monograph concludes in its last sentence (p. 43).

Conclusions Concerning the Projections

The admirable energies of these researchers have provided an important lesson. Projections of labor market conditions are extremely difficult to produce and, upon completion, almost inevitably contain an enormous amount of uncertainty. This point has been made repeatedly in assessments of previous labor market projections for scientists and for teachers, as well as in evaluations of the state of the art.[24]

[24] For example, see Anthony Pascal, ed., Policies for Mid-Life Career Redirection, The Rand Corporation, 1975.

This is not a plea for agnosticism. The argument can be made that the labor market for Ph.D.'s may show a dramatic decline over the next twenty years. The question then must be asked, "What would the effects be?" Interestingly but perhaps not surprisingly, much more attention seems to have been paid to estimating the number of hires, as compared with analyzing why and how such a decline would hurt.

An implicit line of reasoning behind many of the expressions of concern runs something like this:

(1) Research, especially so-called "basic" research, is a public good. So, perhaps is the "health" of America's university system.

(2) A decline in faculty hiring, especially of young people, will harm research and/or will harm the health of American universities.

(3) Universities cannot (will not) act effectively to alleviate that harm.

(4) Therefore, governmental action is prima facie justified.

This is what I will call the "strong argument" for governmental concern. The logic seems straightforward, but both conceptual complexities and empirical uncertainties abound. The next sections of the paper attempt to analyze them.

III.

> Less than 40 years ago the science-government relationship underwent a radical change. It may be on the verge of changing once again, as the principle of government support of science--mainly in the universities--comes under increased scrutiny. Even if it does change, we should not forget the resilience of American science, which moved from obscurity to the front rank in scarcely two generations.[25]

The tangled subject of university research as a public good is explored in a number of recent documents. There is no need to recapitulate here what others have said on this interesting and difficult topic.

Several distinctions may be useful to raise nonetheless. First, it is more difficult to make the "public good" argument for basic research in fields like education and the social sciences than it is in the hard sciences--and the case for history and the scholarly humanities may be harder still.[26] Professor Ernest May, for example, explains that progress in the humanities and the sciences is comparable "only in very unimportant respects." In science, knowledge quickly becomes obsolete, but history is not easily superseded; a "lost generation" may not therefore imply lost knowledge. May believes

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[25] Dr. John Holmfeld, Staff Member of the House Committee on Science and Technology, Wilson Quarterly, op. cit., p. 81.

[26] See, for example, the recent Rockefeller Foundation monograph Coming to Our Senses, and my "Justifying Basic Research on Education," Minerva, Vol. XVI, No. 3, Summer 1978.

it is hard to make a strong case in Congress for public funding of research in history and the humanities.[27] The argument that some minimum number of American historians is necessary to preserve or to transmit a field is possible, but it must consider the presence of scholars abroad and somehow define what "preserving" and "transmitting" mean.

Second, although American universities have enjoyed a "golden age" of growth and expanded funding, it is, according to experts, difficult to say that the quality of American science and scholarship grew proportionately. Among other issues, entering this difficult area would involve detailed citations of the attainments of scientists from other countries, who, despite lesser numbers and lower levels of funding, often have proportionately greater success.

Third, one must explicitly face the question of the losses if there were a temporary decline in science and scholarship nationwide. One question is the resilience of the scientific and scholarly apparatus. One historian of science believes it is quite robust. "If there were a crisis," he explained in a private conversation, "it would be remediable rather quickly." He cited the example of chemistry in Germany in the 1880's and the period after World War II. If there were a decline in the 1980's and 1990's, it would be fairly easily reversible. These assessments are bound to be controversial, but simply to assume the contrary would seem unwise.

[27] Private conversation.

IV.

> On the whole I believe that I may, without fear of contradiction, affirm this, that of the good books now extant in the world more than nineteen-twentieths were published after the writers had attained the age of forty. If this be so, it is evident that the plan of my noble friend is framed on a vicious principle. For, while he gives to juvenile productions a very much larger protection than they now enjoy, he does comparatively little for the works of men in the full maturity of their powers...[28]

A decline in the hiring of new faculty could have several effects on research. (The possibile other effects on the "health" of colleges and universities are discussed below.)

First, there is what might be called the pure numbers effect: as a factor of production is cut back, output declines. The issue is the amount of productivity lost; in particular, can one assume, as many current arguments seem to do, that cutting the number of new Ph.D.'s (or total faculty) by X percent reduces research output by the same percentage? What would be the loss?

Second, one must consider a quality effect. As the number of openings--perhaps especially, the number of career positions in universities--declines, do the very best young people avoid the field, even perhaps to a greater extent than their less able contemporaries?

Third, one must evaluate the research jobs created as well as those lost. Research and teaching are, to an extent, joint products.

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[28] Lord Macaulay, "Copyright. II," Speech of April 6, 1842, in Macaulay, Prose and Poetry, Cambridge, Harvard University Press, 1967, p. 749. The rest of the quote is supplied later in the text.

and outside funds buy some of the research. If teaching jobs are cut back but research funding remains constant, new research opportunities will be created. A constant demand for research will create a constant supply of research effort. The empirical questions are: Where will that new effort be located, and what will be gained and lost from its new location? Here enter a number of important questions, including the synergy between teaching and research, and the idea of "critical mass."

Fourth, there is the vintage effect, the idea that, in academia, younger is better. Young scholars and researchers may contribute more to research than older ones, either by being more productive and creative or by filling lower-status university roles and thereby enabling their elders to pursue their research more productively.

Evidence on these points is seldom adduced in the literature pertaining to our problem. Indeed, in many cases these considerations are entirely neglected.

The Pure Numbers Effect

The pure numbers effect can perhaps best be approached by beginning with some ideas of elementary microeconomics. The usual assumptions regarding production processes suggest that an X percent cutback in a factor of production will lead to less than an X percent cutback in output. There are some constant complementary factors of production; there are decreasing returns; and, in science, the sociology of simultaneous discoveries contains the lesson that ideas are often ripe. If one scientist does not make a certain discovery, another one soon will.

Beyond microeconomics, an even stronger argument still may be made, based on the work of Derek Price and Jonathan and Stephen Cole.[29] They contend that in the fields of the natural and social science they have studied, important discoveries are very disproportionately made by the very top researchers. For example, in many subfields, the top 2 percent of researchers produce 25 percent of the research, and their output is also of higher quality. The evidence is quite overwhelming, and such findings have been replicated by many studies in many fields. Therefore, if the very best remain and weaker scientists are not cut back, the loss in research output might be minimal.[30]

Apparently, this line of reasoning, although based on undeniable evidence, is not completely accepted by many scientists. There are conceptual problems in ever assessing the argument empirically. It is nearly impossible to partial out the independent effect of a few scientists on a field, since it can be argued that their accomplishments rest on the science that others, including the less able, produce. According to Professors Gerald Holton and I. Bernard Cohen, many practicing scientists do not believe in the strong form of the Price-Cole & Cole argument (private conversations). Indeed, Professor

[29]For example, Derek de Solla Price, Little Science, Big Science, New York, Columbia, 1962; Jonathan R. and Stephen Cole, Social Stratification in Science, Chicago, University of Chicago Press, 1973; Cole and Cole, "The Ortega Hypothesis," Science, October 27, 1973.

[30]If the research funds going to the weaker scientists who leave were granted to the stronger ones who remain, it is theoretically possible that total research output would increase. This prospect is unlikely. More believable is the proposition that many college and university teachers do absolutely no research, so that if they left academia (or were not hired originally) the loss to research would be zero.

Jonathan Cole, in a private conversation, said that even he is now "less certain" about the implications of his research.

Well short of proposing that a few people carry a field, however, we must certainly recognize enormous differences in productivity among scholars; and the most productive tend to congregate in the top one hundred (indeed, in the top twenty) major research universities.[31] The effect of a cutback in faculty therefore will depend on who are cut, rather than simply how many. To my knowledge, there are no models of our problem that explicitly state that the least productive schools (or the least productive scholars) would be the most likely to be victimized by the decline. It is true that the existence of tenure restricts the ability of a particular university to substitute high-caliber new talent for older spent bullets. But insofar as university hiring stresses research quality as a major criterion, employment problems are more likely to fall on the least productive scholars and scientists. Research output will go down by a considerably smaller proportion than a decline in manpower (of the magnitudes we are considering).

The Quality Effect

Raising the issue of quality brings us to a second point, which contains a number of interesting aspects. How will the very best potential researchers react to the tightening labor market for academics? This question immediately leads to several others. Do future Ph.D.'s

[31] See, for example, Deitch, op. cit., and Research Universities in the National Interest (a report from 15 university presidents), New York, The Ford Foundation, December 1977. (This report came out of the Seven Springs Conference, Seven Springs, New York.)

in general respond to labor market conditions? Are other labor markets besides academia important in the decision to pursue a Ph.D.--for example, the market for scientists in industry and government? Do the very best behave as the others do? And can universities identify the very best, so that cutbacks in slots may not lead to a proportional cutback in the very best? An outline of some of the evidence pertaining to these difficult questions may be useful.

Richard Freeman, in several works already cited, has argued that the labor market for Ph.D.'s does obey market forces, although with lags and imperfectly. Future students, he maintains, do seem to act somewhat as if they calculated the economic returns before deciding whether and what to study. However, von Rothkirch, in the monograph discussed above, argues that market-based models cannot explain the choice of graduate fields observed in the 1970's; Tables 4 and 5 provide some raw data on graduate enrollments and Ph.D.'s awarded over time for various fields. Table 6 gives the latest enrollment data.

Table 7 shows the number of graduate record examinations taken at various points in the past decade in certain fields. The decline in the 1970's in all fields except biology is notable. But the supply of Ph.D.'s has varied less in some fields that are dependent on the declining academic market than in others that are not.[32] Table 8

[32] On the dramatic decline in graduate enrollments in physics, see Richard Freeman, "Supply and Salary Adjustments to the Changing Science Manpower Market: Physics," American Economic Review, Vol. 65, March 1975. Cartter observes that "students in humanistic disciplines are probably the least well informed and perhaps the least market responsive" (op. cit., p. 244).

Table 4

FIRST YEAR GRADUATE ENROLLMENT (FGE), BY ACADEMIC FIELD

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGRC	2163	2175	2405	2167	2877	3295	3232	3285	3346	3794	4205	5283	5658	5686	6575
ARCH	788	870	962	1084	1272	1554	1719	1900	2108	2779	3322	3515	4224	4970	5564
BIOL	7098	7612	8176	9750	11821	13608	14200	14874	14875	16285	17245	18042	18995	18991	20694
BUSN	17746	19139	20921	24646	32909	38345	40555	46110	49954	55716	61545	66392	66595	69638	82265
COMM	828	956	1082	1300	1534	1746	2256	2902	2454	2652	3785	3987	4377	5081	5683
CPSC	0	0	0	0	424	543	1487	1966	2622	4084	5026	4921	5125	5279	6332
EDUC	70984	80307	89935	97773	106237	120691	125593	151841	170131	180971	191748	189288	197255	215653	224751
ENGN	18915	21532	24047	27355	30245	32512	32278	33734	34438	36626	35477	30545	28501	28763	30914
ARTS	5915	6742	7455	8667	10153	12262	12756	15058	16102	17387	18595	14527	15336	17012	17303
HLTH	3549	3480	3607	4063	4587	5274	5682	5644	7140	7522	8270	12738	15066	17037	19078
LAW	1183	1305	1683	1896	2243	2300	2033	2120	2379	2215	2183	2165	2542	2703	2189
LTTR	12916	14876	16917	20557	24424	28428	29645	33328	33628	35532	36885	38727	37459	34763	34306
MATH	7493	7830	8897	10021	11830	12959	12624	13153	13239	13748	13604	11396	11261	9746	9493
PHYS	12225	12180	13226	14625	16123	16780	16503	17239	16925	16783	17356	15665	15333	14693	14543
PSYC	5521	5655	6252	7042	7678	8765	8453	10130	10645	12200	14262	14754	15678	16219	17270
PUBL	4456	4872	5242	6121	7552	8572	8317	9812	10236	11421	12324	16350	18806	22013	26793
SOCS	18417	20140	21690	25236	31338	35243	35525	39546	39628	44331	47734	45305	43514	42608	41262
PROF	3825	4219	4665	5065	10369	11258	12572	14462	15616	15623	15017	17743	17839	19665	20723
OTHR	2152	3002	3306	3411	4182	4715	5324	10862	12908	14678	19148	15208	15761	11340	11891
TOTL	197180	217492	240468	270839	317808	358850	370772	428026	458334	494363	527834	528151	538985	561860	597695

Source: von Rothkirch, 1978, p. 14.

Table 5

PH.D.'S AWARDED, BY FIELD

	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGRC	588	637	648	699	823	1086	971	1059	930
ARCH	13	18	20	30	35	36	50	58	69
BIOL	2097	2256	2784	3051	3289	3645	3653	3636	3440
BUSN	387	437	445	533	603	810	902	932	983
COMM	90	100	110	115	120	145	111	139	175
CPSC	0	38	51	64	107	128	167	196	138
EDUC	3063	3529	4079	4829	5894	6399	7041	7314	7233
ENGN	2304	2614	2932	3377	3681	3638	3671	3492	3312
ARTS	476	504	528	684	734	621	572	616	585
HLTH	251	250	243	283	357	466	442	646	578
LAW	29	27	36	18	35	20	40	37	27
LTTR	1547	1791	2122	2324	2595	3197	3430	3745	3556
MATH	782	832	947	1097	1236	1199	1128	1068	1031
PHYS	3045	3462	3593	3859	4312	4390	4103	4006	3631
PSYC	1046	1231	1268	1551	1669	1782	1881	2089	2339
PUBL	64	64	77	90	131	178	211	219	230
SOCS	2152	2522	2840	3184	3792	3803	4233	4393	4293
PROF	273	278	337	327	399	474	609	933	964
OTHR	24	31	24	73	55	91	155	193	195
TOTL	18237	20621	23084	26188	29866	32107	33370	34777	[illegible]

PH.D. PERCENTAGES, BY FIELD

	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGRC	3.22	3.09	2.81	2.67	2.76	3.38	2.91	3.05	2.75
ARCH	0.10	0.03	0.09	0.11	0.12	0.11	0.15	0.17	0.20
BIOL	11.50	10.94	12.06	11.65	11.01	11.35	10.95	10.46	10.17
BUSN	2.12	2.12	1.93	2.04	2.02	2.52	2.70	2.68	2.91
COMM	0.49	0.48	0.48	0.44	0.40	0.45	0.33	0.40	0.52
CPSC	0.00	0.18	0.22	0.24	0.36	0.40	0.50	0.56	0.59
EDUC	16.80	17.11	17.67	18.44	19.73	19.93	21.10	21.03	21.55
ENGN	12.63	12.68	12.70	12.90	12.33	11.33	11.00	10.04	9.79
ARTS	2.61	2.44	2.29	2.61	2.46	1.93	1.71	1.77	1.73
HLTH	1.38	1.21	1.05	1.08	1.20	1.45	1.32	1.86	1.71
LAW	0.16	0.13	0.16	0.07	0.12	0.06	0.12	0.11	0.08
LTTR	8.48	8.69	9.19	8.87	8.69	9.96	10.28	10.77	10.51
MATH	4.29	4.03	4.10	4.19	4.14	3.73	3.38	3.07	3.05
PHYS	16.70	16.79	15.56	14.74	14.44	13.67	12.30	11.52	10.78
PSYC	5.74	5.97	5.49	5.92	5.58	5.55	5.64	6.01	6.91
PUBL	0.35	0.31	0.33	0.34	0.44	0.55	0.63	0.63	0.68
SOCS	11.80	12.23	12.30	12.16	12.70	11.84	12.69	12.63	12.68
PROF	1.50	1.35	1.46	1.25	1.34	1.48	1.82	2.68	2.85
OTHR	0.13	0.15	0.10	0.28	0.18	0.28	0.46	0.57	0.58
TOTL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: von Rothkirch, 1978, p. 16.

Table 6

GRADUATE ENROLLMENTS, 1977-78

	Education Number	Education 1-year change	Humanities Number	Humanities 1-year change	Social sciences Number	Social sciences 1-year change	Physical sciences Number	Physical sciences 1-year change	Engineering Number	Engineering 1-year change	Biological sciences Number	Biological sciences 1-year change
Total enrollment												
Highest offering master's degree												
Public institutions	51,436	5.3%	10,666	-8.5%	23,983	+0.6%	3,788	+3.0%	2,775	+2.3%	10,134	-0.7%
Private institutions	9,162	-7.5%	1,479	-8.4%	10,082	+8.7%	569	-1.2%	199	+8.4%	1,877	-11.0%
Total	60,598	-5.6%	12,145	-8.3%	34,065	+2.9%	4,357	+2.5%	2,974	+2.6%	12,011	-2.5%
Highest offering Ph.D. degree												
Public institutions	114,889	-0.7%	49,857	-3.7%	87,155	+2.6%	35,746	+1.6%	31,719	+1.4%	68,548	+4.6%
Private institutions	20,115	-3.7%	18,773	+4.7%	41,353	+3.8%	11,616	-5.1%	15,573	+4.9%	15,878	+3.6%
Total	35,004	-1.2%	68,630	-3.9%	28,508	+3.1%	47,362	-0.1%	47,292	+2.6%	84,416	+4.6%
All public institutions	166,325	-2.2%	60,523	-4.6%	111,138	+2.3%	39,534	+1.7%	34,494	+1.5%	78,680	+4.1%
All private institutions	29,277	-4.9%	20,252	-4.8%	51,435	+4.7%	12,185	-4.9%	15,772	+4.9%	17,749	+2.0%
Grand total	195,602	-2.6%	80,775	-4.6%	162,573	+3.6%	51,719	+0.1%	50,266	+2.6%	96,429	+3.7%
First-time enrollment												
Highest offering master's degree												
Public institutions	8,586	+2.3%	1,919	-3.9%	4,032	+0.0%	629	-2.6%	632	-20.2%	1,851	-0.8%
Private institutions	2,413	-28.8%	501	-11.3%	3,003	-9.1%	208	-2.8%	72	+28.6%	532	28.9%
Total	10,999	-6.6%	2,420	-5.5%	7,035	-4.1%	837	-2.7%	704	-17.0%	2,383	-8.8%
Highest offering Ph.D. degree												
Public institutions	20,186	+0.8%	12,534	-2.6%	21,366	+6.7%	9,066	+7.2%	8,438	+4.7%	16,261	-2.7%
Private institutions	3,910	-1.1%	5,295	-2.2%	11,442	+13.6%	3,051	+2.0%	4,704	+2.1%	3,970	+2.5%
Total	24,096	+0.5%	17,829	-2.5%	32,808	+9.1%	12,117	+5.6%	13,142	+3.8%	20,251	-1.8%
All public institutions	28,722	+1.3%	14,869	-2.8%	25,398	+5.6%	9,695	+6.5%	9,070	+2.5%	18,132	-2.5%
All private institutions	6,323	-13.9%	5,796	-3.1%	14,445	+8.2%	3,259	+1.7%	4,776	+2.4%	4,502	-2.6%
Grand total	35,095	-1.6%	20,249	-2.9%	39,843	+6.5%	12,954	+5.2%	13,846	+2.5%	22,634	-2.5%

SOURCE: COUNCIL OF GRADUATE SCHOOLS IN THE UNITED STATES

Source: Scientific Engineering Technical, Manpower Comments, p. 22.

Table 7

NUMBER OF GRADUATE RECORD EXAMINATIONS
TAKEN IN 1968-69, 1970-71, AND 1976-77 AND
PERCENTAGE CHANGE BETWEEN 1970-71 AND 1976-77,
SELECTED FIELDS

Field	1968-69	1970-71	1976-77	Percent Change 1970-71 to 1976-77
Biology	9,879	14,575	18,300	+26
Chemistry	4,715	5,432	4,500	-17
Economics	3,823	4,915	3,000	-39
Engineering	7,594	8,496	5,500	-35
French	2,402	2,587	900	-65
History	9,041	11,471	3,500	-69
Literature	13,176	15,357	5,900	-62
Mathematics	6,406	7,601	3,200	-58
Philosophy	1,490	1,655	700	-58
Physics	4,280	4,015	2,650	-34
Psychology	12,354	18,441	15,300	-17

*These data were provided by Educational Testing Service. The figures for 1976-77 are estimates.

Source: Deitch, 1978, p. 68

gives the percentage of jobs for new Ph.D.'s that are in academic institutions, by specialty.

Let us tentatively suppose that, on average, the supply of Ph.D.'s is influenced by economic factors. Do the very best potential Ph.D.'s behave as the average ones do? Unfortunately, I could find almost no studies that addressed this question. Estimates of "elasticities of supply" are based on aggregates, and even they contain disturbing anomalies.[33]

In the absence of systematic data, I informally asked several admissions chairmen from around Harvard to assess whether their applications and admittees have been of lower quality over the past years. In particular, have there been fewer very able candidates? Their answers will not, of course, predict what will occur in the 1980's and 1990's, and applicants may behave with inefficient "lags." But it was interesting to note that the very best will seem willing to pursue Ph.D.'s at Harvard.

The basic thrust of the responses is captured in anecdotes cited by Professors I. Bernard Cohen and Willard V. Quine. In private conversation, Cohen noted that in the Depression Era, when he entered graduate school, very few jobs existed for Ph.D.'s, even for scientists.

[33]For example, Freeman ("The Job Market for College Faculty," op. cit.) produces econometric models in which increases in enrollment actually reduce faculty salaries, though increasing employment (p. 47). He flatly states, citing Kenneth Arrow, that "economists lack an adequate theory of salary or price adjustments" (p. 40). On the great sensitivity of labor supply estimates depending on alternative econometric specifications, see Julia Da Vanzo, Dennis DeTray, and David H. Greenberg, "The Sensitivity of Male Labor Supply Estimates to Choice of Assumptions," Review of Economics and Statistics, Vol. 58, No. 3, August 1976.

Table 8

Where American Ph.D.'s Were Employed, 1960-74

	College teaching	Business and industry	Federal government	State or local government	Non-profit institution	Other or unknown
MEN						
Mathematics	75.9%	11.7%	3.2%	0.2%	1.8%	7.2%
Physics	45.4%	25.8%	11.4%	0.5%	3.9%	13.1%
Chemistry	26.6%	56.6%	4.3%	0.7%	2.0%	9.7%
Earth science	45.4%	22.9%	12.8%	3.0%	2.2%	13.6%
Engineering	33.2%	46.8%	6.7%	0.7%	3.4%	9.2%
Agricultural sciences	49.5%	12.5%	10.9%	2.3%	1.7%	23.1%
Medical sciences	52.7%	18.3%	6.5%	4.0%	4.6%	13.9%
Biosciences	60.8%	9.9%	8.3%	2.5%	3.8%	14.7%
Psychology	54.4%	5.3%	5.8%	13.6%	9.9%	11.1%
Economics	68.0%	5.7%	7.5%	1.3%	4.0%	13.5%
Other social sciences	80.2%	2.4%	3.1%	2.0%	3.2%	9.1%
Humanities	88.2%	1.1%	1.0%	0.4%	1.7%	7.6%
Professions	76.2%	5.1%	1.9%	0.8%	8.1%	7.9%
Education	58.6%	0.9%	1.3%	5.4%	3.3%	30.5%
Total	59.7%	14.6%	4.6%	2.8%	3.6%	14.8%
WOMEN						
Mathematics	81.8%	5.0%	1.3%	0.1%	1.2%	10.6%
Physics	59.7%	9.2%	4.9%	0.0%	0.7%	25.4%
Chemistry	48.4%	24.8%	4.1%	0.3%	2.3%	20.2%
Earth science	57.7%	9.8%	9.8%	1.6%	2.4%	18.7%
Engineering	45.7%	26.6%	8.2%	0.5%	2.2%	16.8%
Agricultural sciences	58.3%	[illegible]	5.3%	0.0%	2.1%	23.5%
Medical sciences	63.2%	5.8%	5.4%	5.2%	7.8%	12.5%
Biosciences	68.1%	3.3%	3.9%	1.6%	5.3%	17.7%
Psychology	50.9%	2.0%	3.7%	12.8%	12.2%	18.5%
Economics	69.2%	5.0%	7.7%	0.9%	4.7%	12.5%
Other social sciences	79.7%	1.3%	1.9%	2.5%	4.1%	10.6%
Humanities	85.3%	0.9%	0.6%	0.3%	1.3%	11.6%
Professions	74.2%	1.5%	2.6%	2.1%	6.6%	13.0%
Education	65.8%	0.7%	1.1%	4.0%	3.6%	24.8%
Total	70.2%	2.3%	2.0%	3.5%	4.3%	17.8%
ALL Ph.D.'s						
Mathematics	76.3%	11.2%	3.1%	0.2%	1.8%	7.4%
Physics	45.7%	25.3%	11.3%	0.4%	3.8%	13.4%
Chemistry	28.1%	54.4%	4.3%	0.7%	2.0%	10.4%
Earth science	45.7%	22.6%	12.7%	3.0%	2.2%	13.8%
Engineering	33.3%	46.7%	6.8%	0.7%	3.4%	9.2%
Agricultural sciences	49.7%	12.4%	10.8%	2.3%	1.7%	23.1%
Medical sciences	54.0%	16.6%	6.4%	4.1%	5.1%	13.7%
Biosciences	61.9%	8.9%	7.6%	2.4%	4.1%	15.2%
Psychology	53.5%	4.5%	5.3%	13.4%	10.5%	12.9%
Economics	68.1%	5.6%	7.5%	1.3%	4.1%	13.4%
Other social sciences	80.2%	2.2%	2.9%	2.1%	3.3%	9.3%
Humanities	87.6%	1.0%	0.9%	0.4%	1.6%	8.5%
Professions	76.0%	4.8%	1.9%	1.0%	7.9%	8.5%
Education	60.1%	0.9%	1.3%	5.1%	3.4%	29.2%
Total	61.2%	12.8%	4.2%	2.9%	3.7%	15.2%

SOURCE: "A CENTURY OF DOCTORATES," PUBLISHED BY NATIONAL RESEARCH COUNCIL

From: Chronicle of Higher Education, December 4, 1978.

Yet, the process of self-selection was beneficial; those not strongly motivated by the pursuit of knowledge would not enter; science and scholarship were none the worse for the experience. Quine, in a 1974 article, makes the same point by favorably comparing the (necessarily) ascetic academician of the 1930's with the economically motivated one of today.[34]

For example, Professor John T. Tate, Chairman of Graduate Admissions in the Department of Mathematics, believes that the quality of applicants is not declining and, if anything, that the effect is the opposite. He noted whimsically that there is no reason to do math unless it's the only thing one can do. Ten or fifteen years ago, he said, Harvard got people who did not belong in math. The Department admits about twenty graduate students from around one hundred applicants; the number of applicants may be somewhat down, but the Department still gets the cream of the crop. In science, he opined, the very best students are those that just love the subject, even if they are going to starve. The boom of the 1960's was overdone, he said; it was an artificial state.

Professor Sheldon Glashow, Admissions Chairman in the Physics Department, likewise said that no trends were visible in the quality of applicants or admittees. About fifty students have been admitted from about two hundred and twenty applicants in each of the past seven years. The "very best students" are still coming, he noted. Since the 1960's, he said there may have been a decline in the less qualified class of applicants, but this drop was for the better.

[34]Quine, "Paradoxes of Plenty," Daedalus, Vol. 103, Fall 1974.

Professor G. B. Evans, Director of Graduate Studies in the English Department, said that there is a feeling abroad in the humanities that the very best will not apply because of the job market, but till now he has noticed no decline in the quality of the students admitted in his Department. "Goodness knows we have no shortage of top applicants," he said. The standard of the graduate students in his Department is as good as he has known it in eleven years here. The applicant pool has dropped from around four hundred a few years ago to under three hundred now, "but I think on the whole this is healthy: fewer who don't know what else to do besides graduate school in English now apply." Professor Evans said the "overexpansion" in the 1960's was fueled by incorrect prediction of job surpluses in the 1970's and 1980's. "The result was a lot of shoddy Ph.D.'s." (private conversation).

Professor Ernest May said there was no evidence indicating a decline in the quality of applicants in the History Department.

It is probably the case that the most able are the most dedicated to the nonmonetary rewards of research and scholarship. It is not direct evidence to cite Table 9 here, which shows the choices of specialization of National Merit Scholars over time; but they do choose more academic majors than the average student. Even regarding the monetary side, a simple model can be used to indicate that, other opportunities remaining the same, a cutback in jobs will affect the educational investment decision of the person with high ability less than it will the person with low ability.[35] For both reasons, it is dangerous to reason from averages and elasticities calculated from aggregated data. The effect of a decline in the academic market on the most able is likely to be less pronounced for the very able person than for the average.

This is a useful point, but it is not decisive, because it is a relative statement. If the academic job situation becomes bleak enough, it is possible that very few of the very able will remain, even if even fewer of the not-so-able stay. The problem may not be that <u>relatively</u> more of the able remain, but that <u>absolutely</u> too few do. And here it is worthwhile to speculate--I have been unable to find evidence on this point, so speculation is the only appropriate term--on just what sorts of academic jobs do motivate the very able.

It is plausible to hypothesize that the very able are not motivated by the probability of a mundane academic appointment. Possibly, they may consider the only valuable positions to be those at major research univeristies, of which there are twenty-five or one hundred or two hundred or...depending on one's definition and depending on the field. And perhaps only permanent career openings,

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[35] Define "ability" as the probability of getting a job upon receiving the Ph.D.; that is, assume Ph.D. hiring is done according to ability, with some uncertainty. Assume that before investing in higher education those with more ability have a higher average assessment of their own ability and those with less ability a lower average self-assessment. Both groups invest in higher education according to their assessments of their own probabilities and of the alternatives open to them. Now suppose the overall number of jobs goes down. The probability of getting a job given that one is less able goes down more than the probability of getting a job given that one is more able. If other opportunities remain the same, a smaller proportion of the more able will change their investment decision than of the less able.

Table 9

Percent distribution of the fields of college major chosen by National Merit Scholars, 1966-76

Field	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
	Percent distribution										
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Science and engineering	62.3	63.8	66.6	66.6	68.6	68.1	69.1	68.3	69.8	68.5	70.4
Engineering	8.6	10.4	10.6	9.9	12.9	9.4	8.5	9.0	11.2	14.2	16.5
Science	53.7	53.5	56.0	56.7	55.7	58.7	60.7	59.3	58.6	54.3	53.9
Physical and natural sciences	36.2	36.6	37.0	36.2	36.9	36.4	33.5	32.6	32.4	28.2	29.8
Physical sciences	14.2	13.3	11.9	11.1	12.4	10.1	8.5	8.0	8.9	7.1	8.6
Chemistry	6.0	5.4	4.1	3.7	4.6	4.0	2.9	2.6	3.1	2.6	3.0
Physics	7.6	7.0	6.9	6.4	6.2	5.0	4.2	4.4	4.4	3.6	4.4
Other physical sciences	.6	.9	.9	1.0	1.7	1.1	1.5	1.0	1.4	.9	1.2
Life sciences	6.2	5.2	3.3	4.3	3.2	4.2	4.1	4.4	4.6	4.1	6.2
Mathematics	14.1	15.4	12.2	12.2	11.8	12.8	10.1	10.1	7.8	6.8	8.0
Unspecified physical and natural sciences	1.7	2.7	9.6	8.5	9.5	9.3	10.8	10.2	11.1	10.2	9.7
Pre-medicine	5.2	4.4	5.8	6.4	5.9	7.2	11.0	11.3	10.1	11.4	11.3
Social sciences	12.3	12.4	13.2	14.1	12.9	15.2	16.1	15.4	16.1	14.7	12.8
All other fields and "undecided"	37.7	36.2	33.4	33.4	31.4	31.9	30.9	31.7	30.2	31.4	29.0
Health professions	1.5	1.0	.9	1.8	1.6	1.5	2.5	2.5	1.9	2.9	2.3
All other fields	24.1	23.3	28.2	27.6	26.1	26.3	24.9	25.6	23.5	24.1	22.6
Undecided	12.1	11.8	4.3	4.0	3.7	4.1	3.5	3.6	4.8	4.4	4.1

NOTE: Detail may not add to totals because of rounding.

SOURCE: National Merit Scholarship Corporation, *National Merit Scholarship Corporation Annual Report*, annual series.

Source: Science Indicators 1976, p. 288.

rather than tenuous, short-term research slots, are considered worth striving for. <u>If</u> these hypothetical relationships hold, then the question becomes, how many tenured openings are there, over time and across fields, at the major research universities?

Numerous inquiries along these lines have unearthed no solid projections. A one-time study of "doctorate-level science and engineering departments" in 1974 revealed different percentages of faculty with tenure, as summarized in Table 10. Apparently, no one has yet carried out the following calculations:

- <u>Projecting the enrollments of the major research universities over time</u>. It is likely that most of these universities will suffer no cutback in enrollments, since most have many more applicants than positions.
- <u>Estimating the effect of age structure on retirement rates over time</u>.
- <u>Estimating the effect of declining salaries on the rates of voluntary shifts to nonacademic employment</u>.
- <u>Estimating the effect of constant or moderately declining federal outlays (in constant dollars) on tenured positions</u>.

In the absence of such projections, only a few crude generalizations can be advanced. <u>First</u>, since overall enrollments at these universities is likely to stay about the same, the choice of subjects by students becomes especially important in determining hiring needs.

Table 10

Tenured faculty as a percent of full-time [illegible] faculty in a sample of doctorate-level science and engineering departments by selected fields, 1974

Selected fields	Total faculty	Number with tenure	Percent with tenure
All science and engineering fields	28,636	20,051	70
Chemical engineering	891	719	81
Physics	3,356	2,607	78
Electrical engineering	2,092	1,612	77
Botany	636	491	77
Chemistry	3,058	2,355	77
Geology	1,145	858	75
Zoology	914	650	71
Biology	1,969	1,353	69
Economics	2,020	1,362	67
Mathematics	4,064	2,721	67
Biochemistry	1,516	997	66
Microbiology	1,209	784	65
Psychology	2,917	1,836	63
Sociology	1,781	1,066	60
Physiology	1,082	640	59

SOURCE: National Science Foundation. *Young and Senior Science and Engineering Faculty, 1974: Support, Research Participation, and Tenure* (NSF 75-302), pp. 20, 24, and unpublished data.

Source: Science Indicators 1976, p. 278.

For example, Table 11 presents data on past trends and future projections of the fields in which bachelors degrees were earned across all universities. The projected increase in psychology and the decrease in physical sciences are noteworthy.

Table 11

PERCENTAGE CHANGES IN BACHELORS DEGREES BY SUBJECT AREA

	1963-4 to 1968-9	1968-9 to 1973-4	Projected 1973-4 to 1983-4
Social Sci.	+85	+28	+ 1
Psychology	+121	+79	+47
Humanities	+75	+28	+7
Mathematical Sciences	+44	+ 8	+12
Engineering	+23	+ 4	+ 3
Physical Sciences	+23	0	-14
Biological Sciences	+55	+33	+10
All fields	+56	+34	+ 5

Source: Cartter, op. cit., p. 227.

Second, policies toward retirement will play an especially critical role at these universities.

Third, if inflation remains high, it may help universities to cut the real wages of the less productive tenured faculty, thereby encouraging out-migration. The sign of this effect is clear, but its magnitude is suspect.

Fourth, as the percentage of tenured faculty increases, more pressure will be felt on the tenure system itself and on the common practice to equate salaries across departments and across professors with equal seniority.

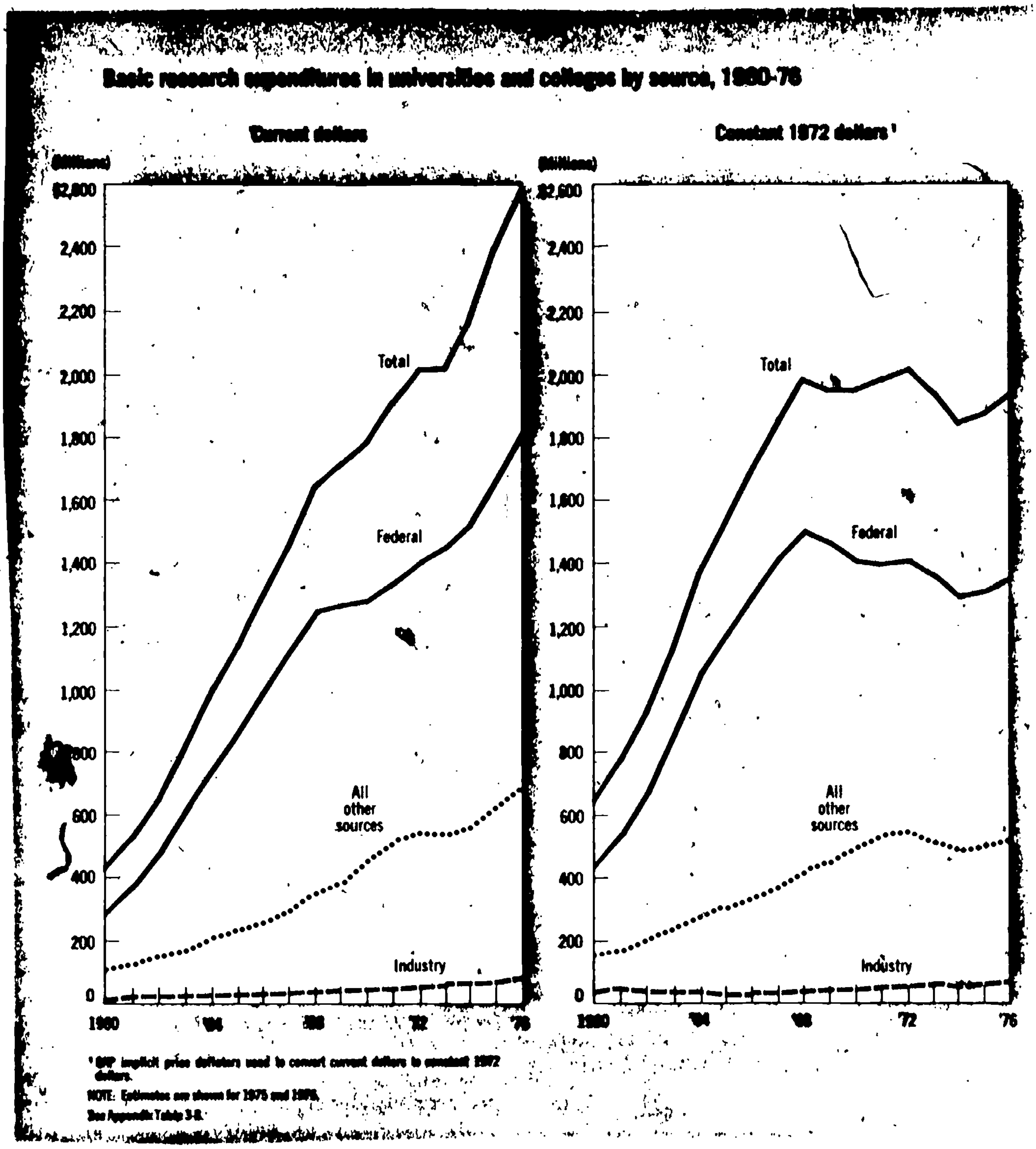
Research Funding and Academic Jobs

In fiscal year 1975, "the major agencies purchasing services from universities and colleges had obligations amounting to $4.5 billion, and $2.8 billion of that total--62 percent of it--was for academic science." Eighty-two percent of these funds for science were received by the hundred universities (47.5 percent by thirty).[36] According to Deitch, in FY1975 Harvard had current-fund revenue of $253 million, of which $65 million, or 26 percent, came from "obligations to selected federal agencies."[37] Basic research by universities rose by 5 percent in constant dollar terms from 1974 to 1976 while all other performers of basic research declined; but federal support for basic research, as shown in Figure 6, has declined in real terms since 1968. (The number of research papers, however, shows a relatively

[36]Deitch, op. cit., p. 119, 120.

[37]Ibid., p. 122.

Figure 6



Source: Science Indicators 1976, p. 76

smooth growth since 1960.)[38] Obviously, much of academic science depends on federal funding.

As enrollments decline over the next twenty years, will academic jobs decline proportionally? Or will the presence of continued research funds maintain some of those jobs at universities? A very simple model may help. Suppose at a certain university that all faculty members spend half their time teaching and half doing research. Suppose, too, for simplicity that the research effort is completely compensated by outside grants. Now suppose enrollments drop so that only half the former amount of teaching need be done. The employment of faculty members would go down by one quarter, and everyone left would spend two-thirds time on research. The "public good"--research--is still produced.

This model, while hardly realistic, effectively conveys a point frequently overlooked in studies of the declining academic labor market. If university research funds stay the same, jobs will not be reduced in direct proportion to declines in teaching. More generally, if research is purchased at the "right" level now and if it is fairly paid for, then a decline in enrollment and in teaching chores need not lead to a decline in research effort. The issues then become: Is the right level now being purchased? Is a fair price now being paid for the "public good" being produced, namely, research? If so, perhaps there is no problem.

[38]National Science Board, Science Indicators 1976, National Science Foundation, Washington, D.C., U.S. Government Printing Office, pp. 76, 88.

I believe three other factual questions are relevant here. First, as teaching jobs go down, where would the research effort occur? It might happen that the remaining university faculty would simply pick up the slack by extending their own research efforts, as in the model above. Or, it might be that the research demand and reduced academic supply would lead to the creation of new research jobs in industry, government, and so forth. Finally, the market might produce more purely research jobs at universities. Probably, a combination of the three would occur. I have found no references to or estimates of the likely empirical magnitudes.

Second, insofar as research would be drawn away from universities (or, in a different version of the question, away from those who teach), would there be undesirable losses in quality to the research (or the teaching)? I interviewed a number of experts of this question, who informed me that although "hunches" on this issue abound, there is very little evidence. Scholars have noted the differences between the "research institute" approach of France and the Soviet Union (for example), where research and teaching are separated; and our own, more integrated approach. However, as Thane Gustafson points out, it is almost impossible to extricate the effects of different ways of organizing research from the myriad social, economic, and intellectual variables that also differ.[39] Professor I. Bernard Cohen said that many American

[39] Thane Gustafson, Why Does the Soviet Union Lag Behind the United States in Basic Science?, Center for Science and International Affairs, Kennedy School of Government, September 1978.

scholars intuitively feel that there is a synergy between teaching and research, and some cite the Center for Advanced Studies at Princeton as an example of a relatively unsuccessful separation of the two. But he said he knows of no useful evidence on the subject (private conversation).

The point is often made that sometimes at universities teaching and research are "joint products." Conceptually, there is no agreed-upon way to partial out the cost of doing one if the costs are joint.[40] However, simply to cite the fact that teaching and research are jointly produced does not, by itself, imply much for our case. The issue is whether the research component is fully paid for by the (social) beneficiaries. Several studies suggest that universities "make money" on the overhead from research--although, since many costs are joint, it is difficult to establish the point.[41] If so, then research subsidizes teaching, and withdrawing research from the teachers would save money which might then be used for additional research.

On the other hand, some studies suggest that graduate training is subsidized by undergraduate students.[42] To the extent that (subsidized)

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[40] For a discussion of this problem with regard to a teaching hospital, see John Koehler and Robert Slighton, "Activity Analysis and Cost Analysis in Medical Schools," Santa Monica, Calif., The Rand Corporation, P-4954, Feb. 1973.

[41] David Garvin, a doctoral student at MIT, claims to have established this fact for his institution (private conversation).

[42] "We have seen that graduate costs are at least three times as great as undergraduate costs, and the ratio becomes 1/6 if research is treated as an input into graduate education. Yet tuition charges are almost identical across levels, and graduate students are frequently given waivers of the nominal amount. Clearly, they are the recipients of huge social subsidies--from governmental and philanthropic sources and, in private universities, from undergraduates as well." Estelle James, "Product Mix and Cost Disaggregation: A Reinterpretation of the Economics of Higher Education," Journal of Human Resources, Vol. 13, No. 2, Spring 1978, p. 157.

graduate students contribute to the research work of their professors, one might argue that research could be done more cheaply at a university than in a place where full costs would be paid.

This leads to a third point of considerable interest. Is a "critical mass" of doctoral students or of faculty members important for the production of research? One scenario has the decline in jobs over all universities lead to a decline in Ph.D. students at the best universities, which in turn leads to a lack of critical mass to support specialized, advanced seminars. Then professors are no longer able to spend as much of their time doing closely research-linked teaching, but have to teach more elementary courses; and their research therefore suffers. Thus, it is not that, in a decline, professors will have to teach more courses (for the student-faculty ratio will remain the same) but less research-related courses. Without a critical mass of graduate students, optimal specialization cannot occur--or so goes the argument.

Another related view traces the scale effect or critical mass phenomenon to the number of faculty in a department (or field).

Several factual questions are important in assessing these critical mass arguments. First, how would a field contract in a decline? Would all Ph.D. programs cut back equally? Or, more likely, would the weakest Ph.D. programs disappear and the strongest remain at close to optimal size? Insofar as academic survival of the fittest occurs or can be encouraged, the second outcome is more likely.[43] If so, scale effects on research production within the remaining departments are not likely to change.

Second, are most departments at the critical mass now, or are many well beyond it? Fortunately, a study of this kind has already been carried out. Allan Cartter provide a summary:

> Judging from the size distribution of the leading graduate departments in the ACE surveys of scholarly reputation, many of the distinguished departments were considerably larger (sometimes by a factor of three) than necessary to achieve critical mass. In a field such as history, for example, the four smallest departments in the top-ranked one-fourth of departments in 1964 had 18 FTE faculty, 85 FTE students, and produced 7 Ph.D.'s annually. The average size for all high-quality departments was 32 graduate faculty, 185 students, and 12 Ph.D.'s. The small departments were more efficient in the number of doctorates awarded as a percent of enrollment and in Ph.D. output per faculty member. This experience was duplicated in most fields, suggesting that high-quality efficient doctoral programs could function at about half the size of the average outstanding department in the mid-1960s.[44]

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[43]There is already evidence that the lowest quality programs are being cut first (although there are also important forces at work to keep the weaker programs alive; the future outcome is unclear). The State Department of Education in New York began a detailed review of doctoral programs, field-by-field, eliminating those programs judged to be lacking in quality. The California Department of Finance submitted doctoral programs within the University of California to intense scrutiny of time-to-degree and attrition, comparing the UC system to several other universities on these productivity measures; a major change in the State's budgeting system was proposed as a result of this analysis. In Missouri, Governor Bond called for creation of an academic common market among states in that region to reduce the number of doctoral programs required in each state. ("Outlook and Opportunities for Graduate Education," National Board on Graduate Education, Washington, D.C., December 1975, p. 18.)

[44]Cartter, op. cit., pp. 244-5.

Can Universities Identify Great Researchers?

If graduate enrollments decline over time, it becomes all the more important to be able to identify in advance those most likely to become great academics. As an illustration, suppose a fifth of the applicants to a department are excellent, the rest not. Suppose the number of seats in the department goes down by half. Will the probability of selecting the very top applicants also drop by half?

If the same people apply and admissions are purely random, the department's number of excellent students will drop by half.[45] But if admissions committees can identify the very best with certainty and the same people apply, the number of excellent students will not decline at all.

The empirical question therefore is; can admissions committees identify the very best among those who apply? Current evidence seems to lead to a negative answer. Above a certain minimum threshold, neither GRE scores or college grades give clear signals about who will be the stars in graduate school or, more importantly, who will be the stars in academic careers five or ten years out. It is worthwhile to summarize a few recent studies on this matter.

[45] Actually, the answer depends on the relative propensity of the top students to apply. As argued above, we expect the top applicants to apply relatively more often than the lesser qualified applicants, so the number of top applicants admitted will not drop by half, even if admissions are random.

• Kenneth Wilson of the Educational Testing Service has recently completed a path-breaking study of the predictive power of GRE's at some of the nation's very best universities.[46] The results are summarized in Tables 12 and 13. Wilson said that no work had yet been done to look beyond overall correlations, which measure the linear relationships between variables, in order to see if the very best performers could be found. (Even if the linear relationship is weak, beyond certain thresholds the tests may be strong predictors of "stars.")[47] Wilson said that "logistical and political difficulties" had precluded such an analysis of his data (private conversation).

• Benjamin Schrader has completed a study that is pending publication by ETS on the relationship between GRE scores and professional success in psychology. A sample was drawn of male academic psychologists ten years out from their Ph.D. awards. Directories were used to get background information. Psychological Abstracts was used to obtain the number of publications. Citations to publications were also tabulated. The results showed a (rather strong) 0.4 simple correlation between GRE scores and citations and a positive but lower correlation with the number of articles published.

[46] Kenneth M. Wilson, memorandum on GRE Cooperative Validity Studies Project, Graduate Record Examinations Board, 1978.

[47] On the general issue, see my "Going Beyond the Mean in Educational Evaluation," Public Policy, Vol. 23, No. 1, Winter 1975, and "Identifying Exceptional Performers," Policy Analysis, Vol. 4, No. 4, Fall 1978.

Table 12

SUMMARY OF DATA SUBMITTED AND OBSERVED VALIDITY PATTERNS, BY FIELD: GRAD GPA CRITERION

Field/ Department	Number of Samples								Weighted Mean Coefficients			
	GRE-V [Aptitude]	GRE-Q	GRE-Adv		UGPA				GRE-V	GRE-Q	GRE-Adv	UGPA
Biosciences[a]	22	(12)*	13	(2)	14	(5)			.19	.25	.37	.24
Chemistry	12	(6)	7	(5)	8	(7)			.06	.25	.39	.31
Engineering[b]	10	(4)	4	(0)	5	(2)			.28	.30	.28	.20
Mathematics[c]	6	(3)	2	(0)	2	(0)			.32	.23	.35	.30
Physics	5	(3)	4	(3)	2	(2)			.05	.16	.19	.29
Geol, Geophysics	5	(1)	4	(1)	1	(1)			.05	.06	.11	.37 **
Economics	6	(4)	3	(3)	3	(3)			.09	.34	.45	.27
Anthropology	3	(2)	-	-	1	(1)			.26	.21	-	.06 **
Education[d]	7	(6)	2	(2)	5	(5)			.18	.12	.54	.24
English	6	(3)	5	(0)	4	(2)			.41	.24	.48	.22
History	10	(10)	7	(3)	8	(8)			.31	.26	.21	.30
Pol Science[e]	4	(4)	2	(1)	3	(3)			.43	.34	.49	.18
Psychology	12	(10)	7	(5)	7	(4)			.24	.26	.37	.22
Sociology[f]	7	(5)	3	(1)	5	(4)			.43	.30	.54	.55
Library Sci	3	(3)	-	-	3	(3)			.32	.52	-	.33
Fine Arts[g]	6	(6)	-	-	5	(5)			.33	.26	-	.31
Music	3	(3)	2	(1)	1	(1)			.24	.11	.21	.23 **
Philosophy	5	(0)	2	(0)	2	(0)			.25	.14	.23	.56
Languages[h]	5	(1)	2	(0)	2	(0)			.31	.20	.45	.28

NOTE: The validity coefficients shown are weighted averages of obtained coefficients. Patterns of medians are similar.

*Ns in parentheses indicate the number of samples for which N=25 or greater, based on data for two years—1974-75 and 1975-76 in almost every instance.

**Coefficient based on one sample only.

[a]Includes Oceanography, Marine Environmental Science, Allied Health Science

[b]Includes Engineering and Facilities Management

[c]Includes Computer Science, Applied Math and Stat

[d]Includes Vocational and Adult Education, Educ Administration

[e]Includes Public Administration

[f]Includes Social Work, Urban Planning, Public Policy Studies

[g]Includes Speech and Theater, Drama & Communication, Speech & Comm, and Journalism

[h]Includes two Hispanic, one Germanic, one French, and one undifferentiated Foreign Languages & Literatures

Source: Kenneth M. Wilson, memorandum on GRE Cooperative Validity Studies Project, Graduate Record Examinations Board, 1978. "Validity coefficients" are (zero-order) correlation coefficients.

Table 13

CORRELATION OF PREDICTORS WITH GRADUATE GPA AT HARVARD

Department/ Group (N/coefficient)		Predictors GRE-V r	GRE-Q r	GRE-Adv r	UGPA r	Adm. Rank* r	Criterion	Mean	S.D.
English									
(12/12/11/15/14)	"White"	.07	-.13	.54	.29	.13	GPA Cum	10.32	0.38
(15/15/14/18/17)	Total	27	-.06	.60	.38	.05		10.33	0.38
History									
(15/15/13/30/30)	"White"	-.02	.23	.09	-.10	-.25	GPA Cum	9.99	0.80
(17/17/14/32/34)	Total	-.15	.12	.09	-.11	-.19		10.05	0.79
Psych-Soc Rel	Total	-.22	-.23	.36	-.38	.34	GPA Cum	10.24	0.38
(12/12/11/13/13)	[Miller Analogies, r = -.05 with GPA Cum]								
Philosophy (05/05/05/07/07)	Total	.12	.30	.24	-.45	-.33	GPA Cum	10.03	0.63
Physics									
(16/16/16/17/17)	"White"	-.01	.30	-.11	.62	.38	GPA Cum	9.86	0.79
Economics									
(12/12/08/14/14)	"White"	.26	-.26	.52	.00	.61	GPA Cum	10.01	0.68
(23/23/17/21/29)	Total	.40	-.08	.57	-.01	.37		9.91	0.65
Geology									
(--/--/--/08/08)	Total	(GRE not avail.)			-.12	.07	GPA Cum	9.37	0.92

Note: Ns in parentheses indicate the number of cases used for the respective predictor-criterion correlations.

*Ranking is an inversely scaled variable. Signs of coefficients have been reflected. Thus positive and negative coefficients may be interpreted as though this variable's scale had been positively oriented prior to analysis.

Source: "Study Report for the Departments of English, Social Relations, History, Philosophy, Physics, Economics in the Graduate School of Arts and Science of Harvard University," GRE Cooperative Validity Studies Project, Graduate Record Examinations Board, May 1978, mimeo.

• Mary Jo Clark and John Centra, also of ETS, have produced the first draft of a complicated path analysis relating GRE's and other variables to number of publications three to five years after obtaining the Ph.D. The merits of their study include broad coverage (six small data sets covering chemistry, history, psychology, and the three groupings of physical sciences, biological sciences, and social sciences), an interesting model, and a number of productivity variables (journal publications, book publications, presentations at professional meetings, and income, all self-reported). The problems include self-reporting, a less carefully screened sample, and only three to five years in which to demonstrate productivity. Their findings included: "basically zero" partial correlations between GRE's and productivity (in some cases, the coefficients were negative and statistically significant); "graduate grades didn't correlate with anything" (private conversation); and "no pattern whatever in any of the six fields in the zero-order correlations between GRE's and any of the outcome measures" (private conversation). Concerning exceptional performers, Dr. Clark made a special check of the scattergrams relating GRE's to publications. The patterns were flat, even at the very top GRE's, with occasionally a slightly higher publication record for those with GRE's under 550 (private conversation).

• Professor David McClelland shared the results of work on the effects of Harvard, which includes the predictive power of SAT scores and graduate school performance on later professional success. He also cited the results of several studies done elsewhere. The results show almost no effect of increased scores or higher graduate grades.

In order to appreciate these results, it must be remembered that only those with fairly high GRE's are included in these samples. Beyond some threshold, GRE's do not have great predictive power.[48] It will be hard for graduate schools to keep up the numbers of the very best potential scholars if enrollments go down, unless proportionally more of the very able still apply.

The Vintage Effect

The argument I will call the "vintage effect" comes in two varieties:

(1) Young researchers do more, or better, or more revolutionary research than older researchers.

(2) Young scholars beneficially stimulate their elders: there is generational synergy.

Either or both versions are used to contend that a cutback in the flow of young scholars will have serious effects on research--effects that are not measured fully just by considering the aggregate decline in number of researchers.

The vintage effect is apparently the lynchpin of several arguments that the decline of the 1980's and 1990's will damage U.S.

[48] On some of the statistical problems here, see Robin M. Dawes, "A Case Study of Graduate Admissions: Application of Three Principles of Human Decision Making," in William B. Fairley and Frederick Mosteller, eds., Statistics and Public Policy, Reading, Mass., Addison-Wesley, 1977. For a comparative study of the predictive validity of tests, see my "Choosing the Elite," Comparative Education Review, forthcoming, Summer 1979.

research and scholarship. Consider Radner and Kuh, for example:

> We feel that such steady inflow of younger scholars is important for the vitality of U.S. higher education, and especially for the ability of U.S. science to maintain its internationally pre-eminent place. Older faculty may well be better teachers and expositers of research findings. Young investigators may make some "mistakes" and follow more wrong leads, but they also bring enthusiasm and energy to their pursuit of knowledge. They are important to older faculty, as well.[49]

Dean Henry Rosovsky's 1978 Report makes similar assertions:

> There are several dimensions to this threat. First, the age structure of American faculties will shift significantly....This would obviously have an impact on those fields where knowledge is advanced primarily by young scholars.[50]

Interestingly, these arguments, though widely espoused, are seldom bolstered with evidence. It is true that the vintage effect is hard to gauge. However, at least with regard to the first version of the argument, the available data suggest that age does not affect research productivity, not even in mathematics and science.

Stephen Cole has recently summarized and extended studies of age and research productivity. Cole's abstract states:

> The long-standing belief that age is negatively associated with scientific productivity and creativity is shown to be based on an incorrect analysis of data. Analysis of data from a cross-section of academic scientists in six different fields indicate that age has a slight curvilinear relationship with both quality and quantity of scientific output. These results are supported by an analysis of a cohort of mathematicians who received their Ph.D.'s between 1947 and

[49] Radner and Kuh, op. cit., p. 1.

[50] Henry Rosovsky, Dean's Report, 1977-1978, Harvard University, Faculty of Arts and Sciences (issued November 1978), p. 4.

1950. There was no decline in the quality of work produced by these mathematicians as they progressed through their careers.[51]

Cole argues that the major previous study that indicated otherwise overlooked a simple fact. At any one point in time, the population of scientists is likely to be disproportionately made up of young people, since over the past few centuries science has been growing exponentially. Therefore, if one asks, "What proportion of important discoveries at a given time were made by scientists of different ages?" one does not obtain the answer to the appropriate question, "What proportion of scientists of different ages make important discoveries?"

Using both cross-sectional and time-series data, Cole examines various measures of scientific productivity: number of publications, number of citations to one's recent publications, and age at the scientist's most significant discovery. "...(N)o matter how we classified 'high quality' work the results remained unchanged" (p. 8). Scientists are slightly more productive during their forties; "in most of the fields studied the scientists over the age of 60 were not much less productive than those under 35" (p. 7).

Table 14 summarizes Cole's cross-sectional data on citations in six fields. His tabular method of presenting the results may give those over fifty the appearance of too much productivity, since 50-59 and 60+ are compared with several five-year intervals (35-39, 40-44, 45-49). Cole's longitudinal data on mathematicians, presented in

[51]Stephen Cole, "Age and Scientific Performance," Center for the Social Sciences at Columbia University, Pre-print Series, 1978.

Table 14

AGE AND CITATIONS TO WORK PUBLISHED 1965-1969, SIX FIELDS
MEAN NUMBER OF CITATIONS IN 1971 SCI

	Age						
Field	Under 35	35-39	40-44	45-49	50-59	60+	Total
Chemistry	14.4 (115)	11.4 (62)	20.2 (55)	18.4 (34)	12.1 (61)	7.4 (29)	14.2 (356)
Geology	5.6 (45)	6.5 (60)	7.2 (60)	5.7 (36)	2.7 (49)	1.2 (41)	5.0 (291)
Mathematics	2.7 (101)	3.8 (96)	5.8 (67)	3.4 (63)	5.6 (73)	5.1 (35)	4.2 (435)
Physics	11.2 (138)	15.1 (153)	10.8 (111)	6.8 (84)	7.4 (61)	15.9 (45)	11.5 (592)
Psychology	5.2 (151)	6.6 (101)	6.8 (92)	5.1 (94)	3.3 (79)	3.3 (27)	5.3 (544)
Sociology	.8 (60)	1.6 (41)	2.4 (40)	3.6 (33)	1.8 (39)	1.5 (29)	1.8 (242)

72 73

Source: Cole, 1978, Table 4.

Table 15 does not create this confusion, however, and displays quite clearly a roughly constant productivity over mathematicians' careers. In other tables, Cole shows that those who begin as high-quality producers usually stay that way.

How does this argument apply to scholarship in the humanities and "soft" social sciences? There is no hard evidence on this matter, according to Professors Gerald Holton and Ernest May (private conversations), but the conventional wisdom is that the most important contributions are made by mature scholars. A somewhat dated statement of this proposition, by an historian with a photographic memory, is worth quoting for its beauty:

> It is the law of our nature that the mind shall attain its full power by slow degrees; and this is especially true of the most vigorous minds. Young men, no doubt, have often produced works of great merit; but it would be impossible to name any writer of the first order whose juvenile performances were his best. That all the most valuable books of history, of philosophy, of physical and metaphysical science, of divinity, of political economy, have been produced by men of mature years will hardly be disputed. The case may not be quite so clear as respects works of the imagination. And yet I know no work of the imagination of the very highest class that was ever, in any age or country, produced by a man under thirty-five. Whatever powers a youth may have received from nature, it is impossible that his taste and judgment can be ripe, that his mind can be richly stored with images, that he can have observed the vicissitudes of life, that he can have studied the nicer shades of character. How, as Marmontel very sensibly said, is a person to paint portraits who has never seen faces? On the whole I believe that I may, without fear of contradiction, affirm this, that of the good books now extant in the world more than nineteen-twentieths were published after the writers had attained the age of forty.[52]

Notice that Macaulay includes natural scientists and political economists.

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[52]Macaulay, op. cit., p. 749.

Table 15

MEAN NUMBERS OF PAPERS PUBLISHED AND CITATIONS TO THEM FOR COHORT OF MATHEMATICIANS RECEIVING PHD BETWEEN 1947 AND 1950

Date of Publication	Mean Number of Papers Published	Mean Number of Citations Made in 1975 SCI	Mean Number of Citations Made in Volume of SCI Closest to Time of Publication
1950-1954	2.4	.84	.33 (1961 SCI)
1955-1959	2.8	1.2	.78 (1961 SCI)
1960-1964	2.3	1.1	.96 (1965 SCI)
1965-1970	2.8	1.4	1.4 (1970 SCI)
1970-1975	2.6	1.1	1.1 (1975 SCI)

Source: Cole, 1978, Table 6.

Cole's conclusion is less pronounced: "It is unlikely that an increase in the mean age of our scientists will in and of itself bring about a meaningful decline in our scientific capacity."[53]

What about the argument from generational synergy? Several variants exist. A noble version postulates beneficial intellectual stimulus from having scholars of different ages work together. What is the evidence? Are scientific teams composed of different age groups more productive? In personal conversation, Professor Gerald Holton described his recent attempt to find literature on scientific teams: he said he found almost nothing. (His own recent piece on Enrico Fermi's team is therefore pathbreaking.)[54] He said almost nothing is known about generational synergy.

A less exalted version of the benefits of the young pertains to their exploitability. They may substitute for senior professors on low prestige tasks like undergraduate teaching, serving on committees, and so forth. Or, they may provide a necessary complement to the senior faculty's "production function" for research--playing as it were, the role of semi-skilled labor in the master craftsman's shop. I found little evidence on such matters--except an occasional anecdote, such as David Riesman's complaint that senior professors at Harvard leave too much undergraduate teaching to the juniors:

[53] Cole, op. cit., p. 27.

[54] Holton, op. cit., ch. 5.

> ...Harvard's senior faculty are much less involved with undergraduate teaching and culture than, from the point of view of undergraduates, might be optimal....It has been difficult to persuade senior faculty of top departmental reputation to offer General Education courses or freshman seminars....[55]

Nor did I find a careful consideration of some of the points raised earlier. What would be the net effects of the decline in young faculty, were the hypothesized exploitability true? Would research universities be better places or worse, if senior faculty were forced to teach more? After the decline, would the senior faculty (and the few remaining juniors) have more or less research money per person to work with? Would the aggregate research result be more or less productive, and by how much? And so forth.

Now this is not to deny that young academics have different qualities from older ones. Plausibly, the sociology of universities will be quite different with a mean age of tenured professors of fifty-two instead of forty-five, and a tenure ratio of over 80 percent (to use some figures from Fernandez). Pedagogy might be quite different (whether better or worse is not immediately evident, however). But the argument is not an obvious one; and an alleged drop in the quality of research is a fragile point on which to base one's argument. On the basis of the limited available evidence, the "vintage effect" applied to research does not appear to be a sufficient justification for governmental intervention.

[55]David Riesman, "Educational Reform at Harvard College: Meritocracy and Its Adversaries," in Seymour Martin Lipset and Riesman, Education and Politics at Harvard, New York, McGraw-Hill, 1974, pp. 348, 352.

We come to the end of this section having considered a large number of dimensions to the question, "What would happen if new hirings decline?" The discussion leads me, at least, to doubt many of the negative effects that are widely assumed. Only one finding falls on the other side: current methods for identifying future academic stars before graduate school are surprisingly ineffective. If the decline leads to greatly reduced graduate enrollments, graduate schools may not be able to avoid screening out some of the very best potential researchers--even if the very able are proportionally more likely to apply.

V.

> The labor market for college and university faculty has certain distinct characteristics which affect the operation of the market place: the employing institutions are nonprofit enterprises; both employers and faculty are extremely concerned with quality issues; the internal market of colleges and universities limits variation in salaries across fields and is marked by lifetime employment contracts; the future supply of faculty are "produced" within the system; the scale of higher education depends on the demography of the population....For various reasons, the faculty market is likely to be highly sensitive to exogenous "shocks," with much of the burden of adjustment falling on young faculty and potential faculty.[56]

Why is the prospective decline a public policy question? Why is it not a private problem, much as a decline in domestic shoe sales or fluctuations in the price of sugarbeets? Why cannot universities themselves adjust properly to market changes?

One answer cites the volatility of the labor market for faculty members in the United States, which historically has been notable. Volatility is sometimes considered to be evidence of a "market failure"--that is, the free hand of market forces may lead to a non-optimal allocation of resources. Sometimes governments are therefore moved to intervene, as in the setting of prices for sugar or quantities for salmon. Is there a similar market failure for academic Ph.D.'s?

The answer probably depends more on one's politics than on facts. There is a difference between spoilable commodities like crops or fish and durable commodities like learning; a Ph.D. does not become valueless if not immediately consumed. In the sciences, the value of an

[56] Freeman, "The Job Market for College Faculty," <u>op. cit</u>., pp. 1-2.

education does erode, but not nearly as fast as a tomato. A fluctuation in demand for Ph.D.'s does not therefore lead one to worry as much as in some other cases; it is a loss in welfare for a Ph.D. to wait three years till the market turns, but the Ph.D. is not "lost." Only if the downswing were very long indeed would the resource be lost. (In such a case, the response would appear more like a long-term subsidy than a short-term "buffer" policy to deal with volatility.)

But should the volatility of the academic labor market be taken as a given? Is it the normative baseline for public policy? Might it not be more properly considered the result of policies over which universities themselves have control? If so, it might be argued that what appears to be a market failure at the macro level is really the product of the particular choices of the universities.

For example, consider the tenure system. Much has been written about its costs and benefits, and that discussion need not be reproduced here. It is important to note its central role in the problem under consideration. In the absence of tenure, what would occur given a downswing in enrollments?

Only the most productive faculty at each institution would be retained. If young scholars were thought to have a vintage effect, universities would hire them accordingly. However, the absolute numbers of teachers would decline by the same amount as with tenure (unless the decline is so great that some schools have more tenured faculty than they have faculty slots). Therefore, if one is worried about new hires or about the quality of research, as opposed to the pure numbers effect of declining enrollments, part of the blame should be placed on the tenure system.

Now tenure can be defended on a number of well-known grounds, including political freedom and enabling the selection of new hires to be made by faculty members themselves. This latter feature means that faculty can select new members according to quality, without adverse incentives. In the absence of tenure, all sorts of nonproductive selection procedures might flourish; existing faculty might avoid hiring potential competitors. If one believes in tenure for such reasons, does one therefore have to accept the resulting inefficiencies?

The answer may be "yes," although universities do have means at their disposal for discouraging low-quality tenured faculty. Real wages may be varied, for example. Such practices are ungentlemanly, and they have been infrequent in the recent expansionary period. But they may have to be used much more in the future, as faculty jobs become scarce. An appropriate question for public policy is this: Should the government intervene in the market to save universities from the awkwardness of inducing its less productive tenured members to leave or retire? As stated above, this is more a question of politics than of fact. But it is worth noting that what governmental intervention might really be doing would be reinforcing the tenure system.

Besides volatility, are there other reasons why the declining academic labor market is a public policy issue? If research is a public good and if the research effort will also decline (quantitatively or qualitatively), there is a case for governmental concern; but as we have seen above, this argument is by no means straightforward.

One may anticipate a distributional argument as well. The explosion in colleges and in graduate programs, especially among public institutions, was notable in the 1960's. Cutbacks in enrollments may threaten the newly created public programs most. There may be arguments of geographical or other sorts of equity: "Do not let educational Darwinism operate, for this will drive out the newer schools in relatively far-flung areas that serve non-elite constituencies. Not to act will ensure that the old, elite institutions are the only survivors."

How one feels about such reasoning clearly depends on values as well as facts. But it is predictable that governmental action argued for on grounds of efficiency and the public good of quality research will be confronted with, and perhaps redirected by, such distributional arguments--and that the outcome may favor neither efficiency nor good research.

Finally, there may be an argument that turns on the "health" of American institutions of higher education. To some, this health apparently requires a rapid rate of expansion.[57] To others, it requires a certain scale.

A third position might contend that a balanced age distribution of faculty creates instructional benefits. But why would not

[57]Nathan Keyfitz compares the "golden age of American higher education" (the 1960's) to a chain letter: it was based on "the 7 percent-per-annum expansion of undergraduate education and teaching opportunities," and, in the absence of expansion, the chain ultimately breaks. (Keyfitz also notes, however, that a 10 or even 30 percent decline in higher education might have little effect on research.) Keyfitz, op. cit., p. 90.

universities react accordingly, hiring and raising tuition according to the appropriate principle of maximization? Because people would not pay higher tuitions? But then, are the purported instructional benefits worth it? Or is it a distributional argument: colleges should not make those attending college pay more, and therefore the government should intervene to ensure that college-goers are properly subsidized? (Who benefits? The middle classes?)

Arguments from "health" must first show why health is affected by the decline, then why universities will not themselves act optimally to preserve health, and finally how and whom governmental actions would help. The arguments will be complicated. Merely citing "the health of higher education" as something to be preserved is likely to do little for constructive conversation.

One final point, though obvious, is often overlooked in discussions of the social costs of the academic decline. Those who do not enter academia do not disappear from the planet's surface. Top students who choose law school instead of history may create social benefits in that career; Ph.D.'s who enter the world of business or government may also be socially useful. Consequently, one cannot simply sum up the losses to academia and call them the net social costs. The "lost generation" is not completely lost.

VI.

> Whether, in principle, one should habilitate every scholar who is qualified or whether one should consider enrollments, and hence give the existing staff a monopoly to teach--that is an awkward dilemma. It is associated with the dual aspect of the academic profession, which we shall discuss presently. In general, one decides in favor of the second alternative.[58]

Much of America's prestige in science and scholarship stems from Ph.D.'s produced before 1960; only 9600 Ph.D.'s were conferred in that year, and fewer annually before.[59] Enrollments over the next twenty years will probably decline, but as Figure 3 displayed the levels will remain well above those of 1970 and earlier. It is true that academic openings decline more rapidly than enrollments, and the age structure of current professors will lead to low and then very high rates of retirement, again affecting new hires. But hiring levels may never go below those of 1960, and the effect of a hiring cutback on research is unclear. If the demand for research stays constant, the supply of research effort should remain constant. The effect on teaching is also not obvious: the number of professors will decline, but so will the number of students. The number of young people will decline, and so will the number of talented young people; only IQ transplants can alter that demographic fact. There is no evidence that the most able will avoid academia disproportionately as the market drops and considerable reason to believe they will not. In

[58] Max Weber, "Science as a Vocation," (1918), in Hans Gerth and C. Wright Mills, From Max Weber: Essays in Sociology, New York, Oxford University Press, 1958, p. 130.

[59] Deitch, op. cit., p. 70.

short, it is not obvious there is a public issue here.

Not obvious, but maybe. What is the worst case, what does it imply, what might be done? The demographics may lead to a severe decline in enrollments and an even more severe cutback in new academic jobs for Ph.D.'s. This, in turn, may have unwelcome effects on research:

- Ph.D. granting institutions may become more applied, less specialized, more rigid and old-fashioned.
- Very able students (as well as not-so-able ones) may opt for non-academic educations.
- As graduate enrollments drop, fewer of the very able may enter even if they want to, since graduate schools cannot identify them in advance.
- So, the quality of scholarship and research may decline; many lower-level colleges and universities may fight with the best ones for funds and slots, leading to further erosion; and when enrollments finally increase again twenty years hence, American colleges and universities may be quite different beasts.

What might be done to forestall this uncertain but possibly painful result?

Figure 7 displays the stages at which governmental and/or university interventions might take place. Interventions can be grouped accordingly to the several stages along the way:

(1) Improving the admissions process into graduate schools.

(2) Supporting graduate students.

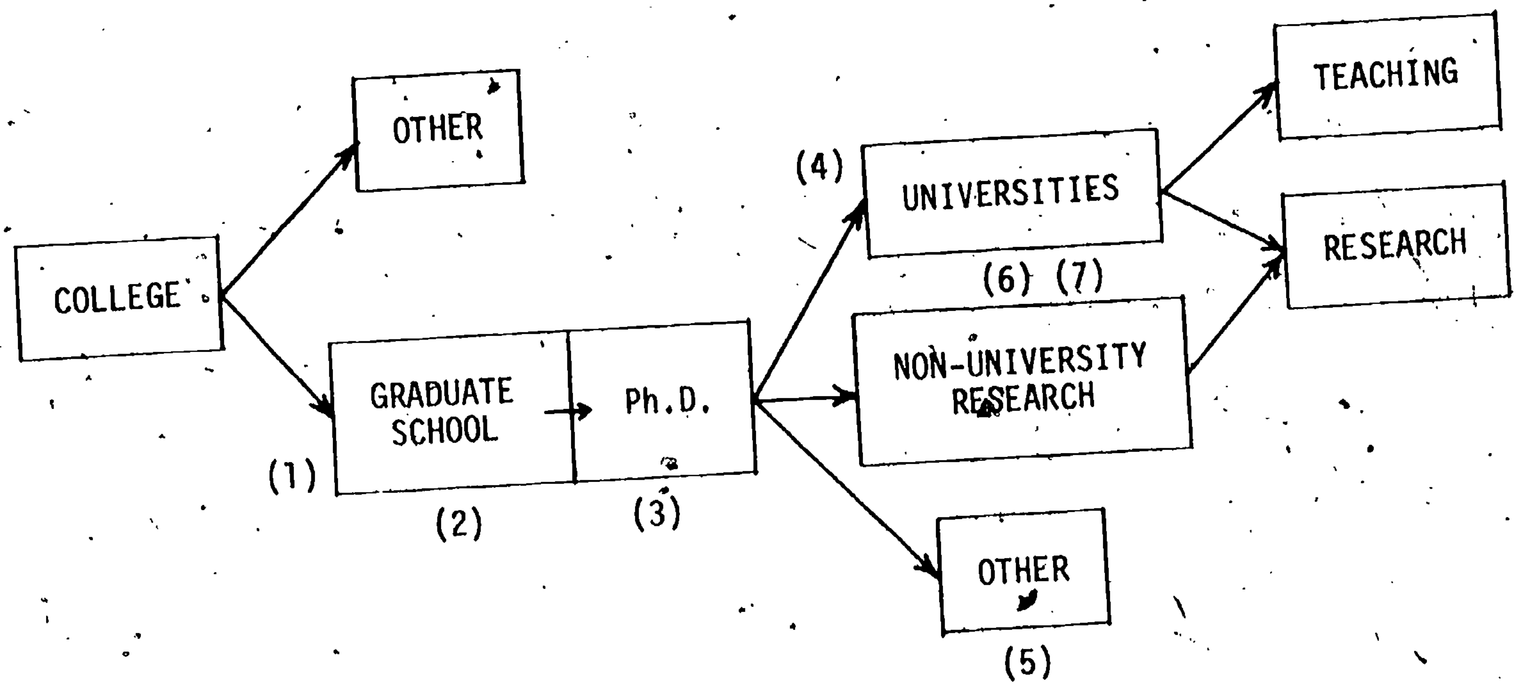

Figure 7. A FLOW CHART SHOWING POSSIBLE POINTS OF INTERVENTION

(3) "Screening" the most able during graduate school.

(4) Improving the academic hiring process for new Ph.D.'s.

(5) Improving non-academic job prospects for new Ph.D.'s.

(6) Creating more jobs in academia by

(a) Subsidizing entry-level jobs.

(b) Subsidizing tenured positions.

(c) Encouraging tenured professors to leave or retire.

(7) Creating more jobs in research by funding more research.

Comments follow on each broad type of proposal. The alternatives are not, of course, exclusive.[60]

(1) Improving admissions processes. Currently, it appears to be almost impossible to identify future academic stars in the large pool of applicants to major graduate schools. If better screening devices could be developed, it might enable universities to survive a cutback in quantities without a proportional decline in quality. However, no attractive lines of action are evident. Additional research, perhaps by universities themselves, would be welcome, but nothing in the way of concrete governmental initiatives suggests itself.[61]

(2) Supporting graduate students. Potential students apparently do calculate the costs as well as the benefits of obtaining a Ph.D.

[60] I am grateful to Patricia Early for a discussion of the pros and cons of many of these possible initiatives.

[61] A simple statistical model may help to explain why simultaneously (1) 2 percent of scholars contribute 25 percent of published research and (2) these scholars are not identifiable in advance. The Poisson distribution is often used to model rare and independent events, such as traffic accidents, arrivals in a bank, or typographical errors. In the case of traffic accidents, for example, it is assumed that each person has the same probability of having an accident, and the number of accidents x which he will have in a given period is given by the Poisson formula: $P(X=x) = \frac{e^{-\lambda}\lambda^{x}}{x!}$, where λ is the Poisson parameter

Federal support for graduate study has dramatically declined over time. One possible federal action is to increase the number of merit-based scholarships, in order to encourage the most able to obtain the Ph.D. The idea is to prevent the supply of the very able from responding to the slackening demand for academicians by subsidizing investment in their human capital.

The NBGE has proposed an increase in merit-based fellowships to 2000 per year. Currently, the National Science Foundation awards 550 merit-based scholarships annually. The proposed increase would include the National Endowment for the Humanities along with the NSF, allocating the awards between them.

The proposal has the advantage of encouraging some of the brightest young people to consider graduate school more seriously. NBGE would allow scholars to choose their own fields, thus eliminating some of the haggling over the allocation of awards across fields.

Disadvantages include the inability to identify truly outstanding scholars in advance, no link to later jobs, and potential wrangling over the allocation of scholars and awards.

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representing the propensity to have accidents.

Now suppose a publication is also a rare event (interestingly, 50 percent of the people in a given field will publish one or zero papers in their academic lifetime). Suppose publishing also follows a Poisson distribution: each person has the same probability of publishing a paper in a given time period, and the probabilities are independent from period to period. Even under this strong assumption of equal *ex ante* propensity to publish, we still might observe the top few percent publishing a large proportion of the articles. The point is that top producers may be on top "by chance"--just as those who have the most accidents may not be accident prone but unlucky.

This is not being advanced as a realistic model; in fact, publications fit an inverse square law, not a Poisson distribution (Price, *op. cit*). Furthermore, high producers early in their career also tend to be so later, which seems to violate the Poisson assumption of independence across periods. The point remains that a good part of academic "stardom" may well be good fortune.

If 2000 new scholars were funded yearly and 6000 at any one time, NBGE estimates the program would cost the government $48 million per year. This estimate assumes each scholar would receive $3500 for personal expenses and the institution he attends $4500 in lieu of tuition. (For each additional $1000 in support, the cost would rise by $6 million.)

(3) Screening during graduate school. If future academic performance were not predictable before graduate school but were predictable after a year or two of graduate study, it might be wise to admit many students and screen them after a probationary period. Unfortunately, the evidence from a number of studies is that on average graduate school grades have no relationship to later academic productivity. In part, this phenomenon stems from the limited variability of graduate grades. To my knowledge, no one has studied the use of grades to identify later "outliers."

Some of the pros and cons of this approach are discussed in Dean Rosovsky's recent report. As in the case of the first option, research seems advisable, but no clear course of federal action seems warranted by existing evidence.

(4) Improving the academic hiring process. I am ignorant of studies on this topic, but my hunch is that current procedures could be improved. The postdoctoral fellowship in the sciences seems to recognize that further information is desirable before contracting a new Ph.D. as an assistant professor. In a period of decline, hiring mistakes may be more costly. To make sure the very best are not missed, more extensive postdoctoral research positions might be created.

Under alternative (6), the creation of research positions is discussed from a different point of view; here, the emphasis is on improved screening rather than a greater number of jobs.

(5) Improving non-academic prospects. If potential Ph.D.'s weigh the economic benefits of the degree, they will calculate, among other things, the probability of obtaining an academic job (perhaps, the probability of eventually obtaining tenure). They should also consider their likely prospects should an academic job not turn up. A program to improve the Ph.D.'s non-academic marketability should, therefore, raise the attractiveness of graduate study, which in turn may keep the very best from going elsewhere. (This is the economic link between the goal of attracting the very best to Ph.D. study and the goal of alleviating the Ph.D. glut.)

Professor Ernest May's program to train humanities Ph.D.'s in business skills is an intriguing example of this policy option. Its advantage is its apparent effectiveness in attracting willing employers and willing Ph.D.'s. It is debatable, however, whether the economic maximizing model applies to very able potential Ph.D.'s; and it is debatable whether such a program therefore will in fact be a significant encouragement for them to undertake graduate study. Further evidence will be welcome; this is an alternative worth following closely.

(6) Creating more jobs in academia. Several variations may be distinguished.

(a) Subsidizing entry-level jobs in research or teaching. Dr. Frank Press (now President Carter's Science Advisor) and several colleagues produced the Report of the Committee on MIT Research Structure several years ago, which argued for the expansion of laboratory research centers closely coupled to departments and cross-departmental groups. The idea was to create research institute not subject to the shortcomings of the European or Soviet models because linked to teaching departments. These centers could "bring in young people, undertake cross-disciplinary research, field research teams along non-traditional lines, put forward pace-setting, competitive research proposals." The Report went into details of structure and the task of implementation, but it is not obvious that the hoped-for interaction would in fact occur (between departments, between teaching and research).

Advantages of the academic research institute include its emphasis on jobs, the connection to existing university activities, and its potential for entering new areas of research not bound by the departmental structure.

Disadvantages include the insecurity and impermanence of the job openings along with the likely organizational difficulties of establishing such institutes (or of disbanding them once underway).

This alternative's additional costs to the government are unclear. Perhaps such institutes would merely be a way to capture on campus the research jobs created as joint teaching/research jobs decline (see pp. above), in which case the additional costs would be low.

Roy Radner and Charlotte Kuh have proposed the creation of a counter-cyclical "buffer stock" of researchers. In their Junior Scholars Program, during trough years the federal government would subsidize research positions for new Ph.D.'s so that 7500 new Ph.D.'s were hired annually. The positions would be eliminated as the academic job market again turned up. It is therefore a policy designed to smooth out the demographically driven fluctuations in new hires expected over the next twenty years.

The advantages are the possible self-liquidating nature of the awards and the politcally saleable analogy to buffer stocks in agriculture and elsewhere.

The disadvantages include the lack of new permanent jobs, the difficulties of designing allocation procedures for the awards (across fields, universities, and scholars), the possible divorce of teaching and research, and the problems of timing the awards to uncertain troughs.

Radner and Kuh estimate costs under various assumptions about the levels of enrollment and demand. From 1984 to 1999, for example, three estimates of the annual average costs are $95.6 million, $42.8 million, and $98.8 million.

(b) Subsidizing tenured positions. Another idea is to subsidize new, permanent jobs for part of the slack period, with universities guaranteeing the posts thereafter. For example, for ten years the federal government and the university might split the salary of a new tenured position, with the university paying the full salary thereafter. By opening up tenured slots, new entry-level positions should also become available as juniors are promoted.

The advantages of this measure include its emphasis on permanent, teaching/research positions, its use of existing institutions, the possible counter-cyclical use of the awards, the sharing of costs, and the guarenteed liquidation of governmental support after a given period of time.

The disadvantages include the difficulties of allocation across universities, fields, and scholars; the possibility of supplanting rather than augmenting regular university hiring (and the problem of monitoring a rule of "incremental hires only"); and the problem of timing the awards optimally.

Costs are difficult to gauge. As an example, suppose 500 new tenured slots are established in each of fifteen consecutive years, and each slot is 50 percent subsidized by the federal government, the other half paid for by the university. The university pays the entire salary after the ten-year subsidy period. The 500 tenured slots per year would be from an eighth to a twentieth of total tenured openings at four-year institutions (there would be unknown variation by field and type of institution).

Suppose the mean salary is $20,000 and the federal government pays half. Real salaries rise by 5 percent a year (for simplicity, assume all professors paid in year t make the same salary). All figures are rounded; dollars are constant dollars. Table 16 gives the results.

Table 16

ONE PROJECTION OF COSTS UNDER A PLAN TO SUBSIDIZE TENURED SLOTS

Year	Total Number of Slots Being Subsidized	(000) Mean Salary	(000,000) Total Federal Cost
1	500	20	$ 5
2	1000	21	10
3	1500	22	16
4	2000	23	23
5	2500	24	30
6	3000	26	38
7	3500	27	47
8	4000	28	56
9	4500	30	67
10	5000	31	78
11	5000	33	82
12	5000	34	86
13	5000	36	90
14	5000	38	94
15	5000	40	98
16	4500	42	94
17	4000	44	88
18	3500	46	80
19	3000	48	72
20	2500	51	63
21	2000	53	53
22	1500	56	42
23	1000	59	30
24	500	61	16

Other projections appear in Tables 17 and 18.[62] The program is expensive: the federal cost could be over $100 million annually. A larger program (with new posts each year for ten years) at higher salaries (say, $25,000) would be even more expensive.

(c) Encouraging tenured professors to retire or leave. The effects of changes in mandatory retirement laws on universities are still unclear, as are the effects of alternative university policies to encourage retirement or taking employment elsewhere.

One proposal would find sabbaticals for outstanding senior professors, thereby opening slots for young scholars. Another proposal, discussed by Radner and Kuh, involves incentives for senior faculty to retire. That each early retirement would on average free resources to hire half an assistant professor seems a plausible assumption to Radner and Kuh: The variable age structure means that a perfectly counter-cyclical retirement scheme is almost impossible--unless, as is unlikely, incentives for early retirement vary from year to year.[63]

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62 These calculations were performed by Patricia Early.

63 Radner and Kuh, pp. 27-32. They cite two studies: Hans Jenny, Early Retirement, New York, Teachers Insurance and Annuity Association, 1974; American Association of University Professors, Special Committee on Age Discrimination and Retirement, "The Impact of Federal Retirement Age Legislation on Higher Education," mimeo, July 1978; and C. Patton, D. Kell, and J. Zelan, A Survey of Institutional Practices and an Assessment of Possible Options Relating to Voluntary Mid- and Late-Career Changes and Early Retirement for University and College Faculty, prepared for the National Science Foundation, Contract No. PRM-7624675, November 1977.

Tables 17 and 18

OTHER ESTIMATES OF COSTS OF VARIOUS WAYS TO SUBSIDIZE TENURE SLOTS

(Calculations by Patricia Early, Kennedy School)

Initial salary = $18,000; 5% ↑ each year
2000 new posts each year for 5 years.
Subsidy to last 5 years.
Subsidy = 1/3, 1/2, 2/3

Year	# receiving subsidy (thousands)	Salary	Subsidy (millions) 1/3	1/2	2/3
1	2	18,000	12	18	24
2	4	18,900	25.2	37.8	50.4
3	6	19,845	39.7	59.3	79.4
4	8	20,837	55.6	83.3	111.1
5	10	21,879	72.9	109.4	145.9
6	8	22,973	61.3	91.9	122.5
7	6	24,122	48.2	72.4	96.5
8	4	25,328	33.8	50.7	67.5
9	2	26,594	17.7	26.6	35.5

Initial salary = $18,000; 5% ↑ each year
2000 new posts each year for 5 years.
Subsidy to last 10 years.
Subsidy = 1/3, 1/2, 2/3

Year	# receiving subsidy (thousands)	Salary	Subsidy (millions) 1/3	1/2	2/3
1	2	18,000	12	18	24
2	4	18,900	25.2	37.8	50.4
3	6	19,845	39.7	59.3	79.4
4	8	20,837	55.6	83.3	111.1
5	10	21,879	72.9	109.4	145.9
6	10	22,973	76.6	114.9	153.2
7	10	24,122	80.4	120.6	160.8
8	10	25,328	84.4	126.6	168.9
9	10	26,594	88.6	133.0	177.3
10	10	27,924	93.1	139.6	186.2
11	8	29,320	78.2	117.3	156.4
12	6	30,786	61.6	92.4	123.1
13	4	32,326	43.1	64.7	86.2
14	2	33,942	22.6	33.9	45.3

However, the potential advantages of improving the age structure, opening up new tenured slots, and offering choices to older faculty members are considerable. This option deserves careful attention.

(7) Funding more research. Another option focusses attention on the demand for research (the supply of research funds). The demand for university positions depends not only on the derived demand for teachers, but also on the derived demand for university-based research; a similar "accelerator model" makes new jobs a function of changes in research funds. University jobs might be maintained by channeling more funds into university research (as advocated, for example, in Jerome Wiesner's November 1978 presentation to Congress, reprinted in the Chronicle of Higher Education).

According to Dr. John Holmfeld, a Congressional staffer, the prospects for increased real funding for basic research are not good over the next few years (private conversation). But research funds might well be used in the 1980's to counterbalance any adverse trends that surface then. Funding 3000 research jobs at $20,000 per year would cost $60 million for one year; maintaining the flow of new jobs over time would obviously be even costlier.

Concluding Remarks

These alternatives briefly discussed here are neither exclusive nor exhaustive; and none looks like a sure political winner. Five years ago, it was proposed in Congress that direct institutional support be given to universities--a direct enough answer to the anticipated decline, but one that then was greeted unenthusiastically in Washington. The stingy climate now abroad in government means that any proposal for federal aid will be subjected to great skepticism. Even the friends of higher education, chastised perhaps by the overexpansion of the 1960's and by the failure of some educators' promises to be fulfilled, may be lukewarm.

The argument for federal aid in this case is not a straightforward and clearly compelling one, in part because the putative decline is doubtful, in part because a decline's effects on the national interest are unclear, and in part because helping higher education cannot readily be distinguished from helping other sectors that may also face declines or fluctuations. No doubt further studies, especially of what motivates able future scholars and of the job situation by field and type of institution, will help in constructing a more convincing case. But much of the argument depends not on concrete evidence (of a lack of tenured jobs, for example), but on careful reasoning about the effects should the worst case ensue. It is not a time, therefore, for dramatic calls to action, based on hard facts; rather, for a warning flag, a call for specific attention to key empirical issues, and a careful discussion, necessarily uncertain and value-laden, of the possible effects.