The Growing Postdoctorate Population at US Research Universities

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Abstract

US research universities are increasingly populated by postdoctoral fellows. Two dimensions of the postdoctoral training have led to this increase. One is the increasing number of new PhDs taking a first postdoc position, and the other involves a lengthening of the duration of an individual's postdoc experience. In this paper, we examine factors contributing to both of these trends. We find that the increased propensity to take a postdoctoral position can be attributed to the increased proportion of PhDs being awarded in the life sciences and the increased proportion of temporary residents in the graduate population. The increased propensity to take a postdoc position also relates to adverse job market conditions experienced by PhDs during the period. Our postdoc duration results suggest that increased duration can be explained in part by the increasing proportion of PhDs awarded to temporary residents and the increased number of degrees being awarded in the life sciences. Adverse job market conditions also appear to play a role. We also find the duration of the postdoc experience to be positively related to the provision of fringe benefits.

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1 Introduction

US research universities are heavily populated by postdoctoral fellows. Indeed, by the National Science Foundation (NSF)'s count there were approximately 30 000 postdoctoral appointees in science and engineering at US universities in the fall of 2001.[1] Only ten years earlier, the number of postdocs stood at slightly less than 23 000.

Eleven universities currently have 500 or more postdoctorates on campus working in the fields of science and engineering. Harvard University heads the list with 1596, followed by the University of California, Berkeley (819), the Massachusetts Institute of Technology (808) and the University of Colorado (796). In terms of the distribution, the top ten universities host almost 25 percent of all postdoctorates in science and engineering and the top 20 host almost 40 percent.[2]

Because postdocs are usually recruited by research faculty and funded through research grants going directly to the faculty principal investigator, university administrators have traditionally paid little attention to their presence and, when asked, often have had difficulty in identifying the postdoctoral population working on their campus.[3] However, as the number of postdocs has increased and their job prospects for an independent research career have declined, the level of their professional dissatisfaction has grown and universities have begun to realize that the complex set of issues related to postdocs can no longer be ignored. A statistic that communicates in part the emerging tension on campuses surrounding postdocs is that there are currently 50 known active postdoc associations on campuses, including those of Stanford, Yale, Johns Hopkins, the University of Illinois and the University of Chicago.

The postdoc position has a long tradition in the United States, especially for certain science and engineering fields. In such fields, for new PhDs with an interest in pursuing an academic career at a research university, the postdoctoral position has become almost a necessary condition given that departments, when making tenure-track hires at the rank of assistant professor, generally direct their searches to the postdoctoral pool instead of those who have just received their doctoral degree. For example, for decades the typical career path of a research life scientist in the United States has involved obtaining a postdoctoral position upon the receipt of a PhD. As of April 1995, approximately two-thirds of the tenured or tenure-track faculty in biology who have received their doctoral training in the US have held at least one postdoctoral position after obtaining their doctoral degree.[4]

Two dimensions of postdoctoral training have changed over the years, however, leading to a dramatic increase in the number of postdocs populating university campuses. One involves the increasing number of new PhDs taking a first postdoc position, including individuals who received their doctoral training abroad as well as individuals from fields that traditionally did not include postdoc work as a component of training. The other involves a lengthening of the duration of individuals' postdoc experience. In earlier years, individuals typically stayed in a postdoctoral position for only two years. This no longer is the case. For example, 35 percent of life science PhDs observed in 1999 were in postdoctoral positions three to four years after graduation, compared to 12 percent in 1977; 20 percent held postdoctoral positions five to six years later, compared to 5 percent in 1977.[5]

In this paper, we examine factors contributing to both of these trends. In Section 2 we present some summary data collected by the NSF on all postdoctoral appointments in science and engineering fields. These data are for all postdoctorates in these fields including those who received their doctoral degrees abroad.

In Section 3 we estimate the propensity of new PhDs to take a postdoctoral position. In Section 4 we examine factors that affect the duration of postdoctoral experience by estimating a model of postdoctoral duration for individuals who have held one or more postdoctoral positions. We are particularly interested in how these outcomes relate to the academic labor market for scientists and engineers, as well as the availability of research funding. Due to data availability, the analysis in Sections 3 and 4 is limited to individuals who received their PhDs in the United States.

2 The US postdoctorate population

In this section, we present some summary statistics on the postdoctorate population in the US from the Survey of Graduate Students and Postdoctorates in Science and Engineering, also called the Graduate Student Survey (GSS), conducted by the NSF and the National Institutes of Health. The GSS survey has been conducted annually since 1966. In earlier years, data were collected from a limited number of doctorate-granting instituions. Starting in 1975, data have been collected from all institutions offering graduate programs in any science, engineering or health field. The 2001 GSS survey covered 11 967 graduate departments at 606 institutions (including 242 master's-granting and 364 doctorate-granting institutions) in the US and outlying areas.

The purpose of the GSS survey is to obtain the number and characteristics of graduate science and engineering students and postdoctorates in US institutions. Data items for the survey are collected at the academic-department level. For postdocs, the survey collects information on postdoctoral trainees regardless of where their degree was awarded. Table 1 presents the number of postdocs from 1987-2001 by broad field category.[6] We see that the number of postdoc positions in science has grown dramatically in the period 1987-2001, increasing by almost 60 percent. During this period, the number of postdocs in engineering has more than doubled. By contrast, the number of postdocs in the biological sciences, which started the period with a very large base, has grown by slightly more than 60 percent.

One factor that has contributed to the rise in the postdoc population relates to the increasing propensity to hire postdocs from those who have received their PhD training abroad. Although NSF does not collect data by country of doctorate, in recent years it has collected data by citizenship status. In 2001, 59.7 percent of all postdoctorate appointees in the US were temporary visa holders, up from 53.6 percent in 1998.[7]

3 The propensity to take a postdoctoral position

We draw on data from the annual Survey of Earned Doctorates (SED) to estimate the propensity of a newly minted PhD from a US institution to accept a postdoctoral position upon graduation. The SED is the census of all PhDs awarded in the United States and is conducted by the NSF and administered by academic institutions at or near the time individuals receive their PhDs. The purpose of the survey is to collect information on the number of individuals receiving PhDs in the US and their demographic and educational background. The survey includes several questions on an individual's postgraduate plans such as:

- How definite are your immediate (within the next year) postgraduate plans?
- What best describes your immediate (within the next year) postgraduate plans?
- For what types of employer will you be working within the next year?

The response rate of the SED is high, with more than 90 percent replying to the survey instrument each year. For the 2001 survey, the response rate was approximately 92 percent.

We limit our study to those trained in one of ten broad fields in science and engineering for the period 1981 to 1999 who indicate that they do not plan to be in a foreign country after graduation. These ten broad fields are agriculture, physics, astronomy, chemistry, computer science, earth science/oceanography, engineering, mathematics, health/medical and biology. In our sample, approximately 64 percent of the respondents indicate that they have made definite plans for work or future study at the time they complete the questionnaire. Another 26 percent indicate that they are negotiating with a specific organization, or more than one; seeking appointment but have no specific organization in mind at this time; and other. Together these activities are referred to as "seeking." The plans of the remaining 9 percent are not known.

We distinguish, where possible, between those taking a postdoctoral appointment at an academic institution and those taking a postdoctoral position in another sector, such as industry or government. The distinction can be made clearly only for those with definite plans since many of those "seeking" do not indicate the sector where they are looking. The distinction is important because a large number of postdoctoral positions are held outside of academe. For example, during the period 1981-1995, of the 69 945 new PhDs with definite plans to take a postdoctoral appointment, 70 percent were headed to academe; the other 30 percent were headed to another sector.

Here we examine the propensity to take a postdoctoral position for those who have definite plans as well as for the larger group of individuals that includes those seeking a position. We define individuals to have definite plans if they are returning to or continuing in pre-doctoral employment or if they have signed a contract or made a definite commitment. The “seeking” group includes individuals who are negotiating with a specific organization, or more than one; seeking appointment but have no specific organization in mind at this time; and other. We define a postdoctoral appointment to be a postdoctoral fellowship, a postdoctoral research associateship, a traineeship or “other study, internship, residency.”

The independent variables in the model are defined in Table 2; means and standard deviations are also presented. In the model, we control for demographic characteristics such as age and gender, citizenship status, marital status, number of dependents and field of doctoral study. We also include variables to indicate whether the respondent worked full time or part time during the last year in graduate school, and whether the respondent attended a top-ten graduate program in the field.

Table 2 shows that for most variables, the means for the “definite” group and the combined group of the “definite” and the “seeking” are similar. One notable difference is that a higher proportion of those with definite plans are US citizens.

The coefficients for the logit equation, estimating the odds that an individual has definite plans to take a postdoctoral position, are presented in Table 3 as well as the standard errors. For ease of exposition we present not only the actual logit coefficients but also the more easily interpreted odds-ratio. By way of example, for a dummy variable such as female, a value of 1.0 of the odds-ratio indicates that the odds of the event in question occurring are the same for women as for men, the benchmark. An odds ratio greater than 1.0 (for example 1.5), tells us that the odds of the event in question occurring for women are 1.5 times those for men or 50 percent higher for women than for men.[8]

The results are presented for the "definite" group as well as for the "definite and seeking" group. The findings are fairly straightforward. We see that relative to biologists (the benchmark), PhDs in all the other nine fields are less likely to take a postdoctoral position. Results for the "definite and seeking" group show that the field with the lowest likelihood of taking a postdoctoral position, other things equal, is computer science with an odds ratio of 0.049. This suggests that computer science PhDs are about 5 percent as likely to take a postdoctoral position as PhDs in biology. Other than biology, the field with the highest likelihood is astronomy with an odds ratio of 0.78, indicating astronomy PhDs are 78 percent as likely to take a postdoctoral position as biology PhDs.

Where the individual trains matters as well. In seven of the ten fields, those graduating from a top-ten program in their field are more likely to take a postdoctoral position than those who did not train at a top-ten program.[9] But exceptions occur: for example, graduates from top-ten programs in engineering are significantly less likely to take a postdoctoral position—an indication, no doubt, of the strength of the market in engineering during this period, especially outside the academic sector.

Personal attributes affect the likelihood of taking a postdoc. Ceteris paribus, older individuals are less likely to accept postdoctoral positions,[10] as are married individuals. The probability of being a postdoc is also negatively related to the number of dependents (other than spouse) that the individual has. These results are consistent with the theory that postdoctoral training is seen as an investment in additional human capital. Thus, individuals who have shorter horizons or capital constraints are less likely to opt for the investment.

Our results also indicate that what the individual did during the last year in graduate school is also important. Not surprisingly, those who worked full time are considerably less likely to take a postdoc position; those who had a fellowship are considerably more likely to take a postdoc position.

Citizenship status also matters, as does the country of undergraduate training. We consistently find that US citizens or permanent residents are less likely to take a postdoctoral position compared to those who have temporary visas (the benchmark). A likely reason that individuals on temporary visas may be more likely to take a postdoctoral position than those who are not temporary residents is that in many cases postdoctoral positions are classified as training positions, which allow such individuals to remain in the United States after receiving their PhD. We also find that those who received their bachelor's degree in the United States, other things being equal, are less likely to take a postdoctoral position.

The results also indicate that the odds of taking a postdoctorate position are consistently higher for those who received their PhD degree after 1981, the benchmark year. Beginning in 1983 the year coefficients are positive and highly significant. The odds ratios show a consistent increase over time through 1994, with a significant dip in the years 1996-1999. By way of example, individuals who got their PhD degree in 1994 were 2.3 times as likely to take a postdoctoral position as those who received their degree in 1981, while those who got their degree in 1998 were only 1.35 times as likely. This could be related to the overall job market boom in the mid- to late 1990s.

Table 4 reports similar results, but this time the period is restricted to 1981-1995 so that we can distinguish those taking a postdoc in academe from the larger group. The sample is restricted to those with definite plans. Prior to discussing the academic results, we note that when the dependent variable remains indicative of a postdoctoral position regardless of sector, the results for this abbreviated period of time (1981-1995) remain fairly consistent with the above findings for the extended period of time (1981-1999). The only exception is that the fellowship variable is no longer significant.

The results are fairly similar when we focus on those taking a postdoc position in academe rather than those taking a postdoctoral position regardless of sector. The only major difference is that those coming from top physics programs are no longer more likely to take a postdoc than their peers from non-top-ten programs. We also find that there is no significant difference between the probability of taking a postdoc in the years 1990 and 1991 and the benchmark year 1981. We have no clear explanation related to this finding.

One objective of this research is to determine the degree to which the probability of taking a postdoctoral position relates to the job market (especially the job market in academe) for newly minted scientists and engineers. Measures of the strength of the job market are notoriously difficult to construct. For example, information on academic job vacancies is not readily available. Here we use two alternative measures of the job market. One is supply-oriented and controls for the number of PhDs minted each year by field. The other is demand-oriented, and controls for the total current fund revenue for all private and public institutions to proxy the demand for PhDs by academe.

Table 5 summarizes results concerning the impact of the size of the PhD's cohort on the probability of individuals taking a postdoctoral position.[11] Generally speaking, we find that the probability of taking a postdoctoral position, either in academe, or in any sector, is positively and significantly related to the size of one's PhD cohort. There are but a couple of exceptions. First, chemists coming from larger cohorts are less likely to report that they are taking a postdoctoral position. Second, biologists coming from larger cohorts are less likely to report that they are taking a postdoctoral position in academe; they are more likely to report that they are taking a postdoctoral regardless of sector. This result is somewhat curious. It may signify that demand for postdoctoral positions in academe did not keep pace with the supply of applicants, causing individuals to search outside academe for postdoctoral positions.

We use the percent change in total current fund revenue for private and public institutions as a proxy for demand for PhDs by academe. The data on the total current fund revenues are from the Finance Survey of the Integrated Postsecondary Education Data System (IPEDS), conducted by the National Center for Education Statistics.

Because total fund revenue data are available only for the period 1980-1995, we estimate the basic postdoc logit equation for this period, substituting the percentage change in current fund revenue for the time variable. (Revenue data for public institutions are available for a longer period of time but are available for private institutions only up through 1995.)

We find the probability of taking a postdoc to be negatively and significantly (at the 1 percent level) related to the percent change in current fund revenue. This is true regardless of whether we focus on the population of "definite and seeking" or simply the population that has definite plans. It also holds when, for the latter group, we examine the probability of holding an academic postdoctoral position, rather than a postdoc regardless of sector.

For the more inclusive time period, 1981-1999, we use the percent change in total current fund revenue for public institutions as a measure of demand for PhDs by academe. Again, we find a negative and highly significant relationship between the demand measure and the probability of taking a postdoctoral position. Both the cohort and current fund revenue results are consistent with the hypothesis that young scientists and engineers seek postdoctoral positions in reaction to unfavorable job prospects in the traditional (academic) sector.

For the more abbreviated period, 1981-1995, we also examine the joint impact of the supply and demand variables at the field level. The cohort results for this joint model are fairly comparable to those reported in Table 5 for all postdocs; there are fewer instances where the cohort variable is significant in the academic postdoc equations. The demand variable is significant with the expected sign in the fields of earth science and oceanography and agriculture for both the postdoc and academic postdoc equations.

We also examine the impact that changes in the NIH budget have had on the probability of taking a postdoc position for the period 1981-1999 for PhDs in biology. We measure changes both in constant and current dollars.[12] We find the probability of taking a postdoctoral position to be negatively and significantly (at the 1 percent level) related to the percentage change in current dollars. We find the relationship to be insignificant when percentage change is measured in constant dollars. The counter-intuitive result for current dollars may reflect changes occurring at the end of the 1990s when the postdoc frenzy had begun to decline as individuals began to choose alternative career paths, and is consistent with our findings that the odds of taking a postdoc dipped in the years after 1995. When we restrict the period to 1981-1995, we find the probability of taking a postdoc to be positively and significantly (at the 1 percent level) related to the percentage change in the NIH budget, as measured in constant dollars. We find the coefficient on percentage change in current dollars to be insignificant.

By way of summary, our results clearly suggest that several factors contributed to the dramatic increase in postdoctoral positions that occurred in the late 1980s and early 1990s. They include (1) the increasing proportion of temporary residents in the graduate population; (2) the increasing proportion of degrees being awarded in biology; (3) the increasing size of PhD classes, especially in the fields of life sciences and engineering and (4) declines in the growth of resources (measured in current dollars) available at both public and private institutions.

4 The duration of postdoctoral experience

As we mentioned earlier, in addition to more PhDs taking a postdoc position, the length of individuals' postdoc experience has also increased over the years. In this section, we first document the trends in the length of individuals' postdoc experience. We then estimate a model to examine various factors that contribute to these trends.

The data used in this section are drawn from the Survey of Doctorate Recipients (SDR). The SDR is a biennial longitudinal survey of doctorate recipients in the US. The SDR is administered by the Science Resources Statistics (SRS) division of the NSF. The sampling frame for the SDR is the SED, which is the census of all PhDs awarded in the US.

The longitudinal nature of the SDR survey permits one to study individuals over time, as they move from one position to another. In most survey years, the SDR asks if the respondent's current position is a postdoc position and if so, the reasons the respondent took the postdoc. The 1995 survey includes a module with retrospective questions on individuals' career histories as well as past postdoctoral positions. Specifically, the 1995 special module ascertains for those who were no longer in a postdoc position the start and stop dates of the most recent postdoc, the second most recent postdoc, and the third most recent postdoc. For those holding a postdoc at the time of the survey, it asks for information on the current position as well as for information on up to two previous postdoc positions.

Based on this information, we calculate the length of an individual's postdoc experience by adding up the total number of months of the individual's current and past (up to three) postdoc appointments. For individuals who report starting a new postdoc position before the previous position has ended, we count the overlapping months only once.

Figure 1 plots the median length of individuals' postdoc experience, by the year in which their doctorate degrees were received. We exclude individuals who received their PhDs after 1990 because many were still in a postdoc position at the time of the survey and, therefore, the median lengths for these individuals are incomplete.

Clearly, the median length of individuals' postdoc experience for the ten fields has increased significantly between 1965-1990. The median length is 24 months for the 1965 cohort and 34 months for the 1990 cohort, a 42 percent increase. The median length peaks at 36 months for the 1981 and 1982 cohorts.

Figure 2 breaks down the median length of postdoc experience by field for the entire 26-year period. It shows that there are significant differences across fields. During this period, biology PhDs stayed in postdoc positions the longest (36 months) followed by astronomy PhDs (29 months). Engineering PhDs stayed in postdoc positions the shortest (14 months).

Figure 3 plots the median lengths of postdoc experience for the largest four fields by PhD year. It shows that the median postdoc length has been going up for biology, physics, and engineering; the trend is most pronounced for biology. The median length for chemistry postdocs has stayed fairly flat.

To examine factors that have contributed to this trend in the lengthening of postdoc experience, we estimate a model in which the length of postdoc experience is explained by a variety of variables, including an individual's demographic characteristics such as age, number of dependents other than spouse in the household, marital status, race, gender and citizenship status. The demographic variables are measured at the time individuals received their PhDs. We also include in the model indicators for an individual's PhD year, field, and whether the most recent postdoc position offered pension and health benefits.

We restrict the analysis to those who have held at least one postdoc position and at most three postdoc positions, because the retrospective questions ask information only about the three most recent postdoc positions. Moreover, we restrict our sample to those who received their PhD between 1975 and 1990 because information on postdoc experience for many individuals in the later cohorts was incomplete at the time of the 1995 SDR survey.

As with Section 3, we focus on ten broad field categories. The postdocs in these ten fields represent over 80 percent of all postdocs in the sample. Of these fields, biology postdocs make up more than half (55.7 percent) of all postdocs, followed by chemistry (12.0 percent), engineering (9.7 percent) and physics (8.5 percent).

Table 6 provides the summary statistics of these explanatory variables for the postdoc sample as well as for the full sample. Table 6 shows that, compared to the full sample, individuals in the postdoc sample received their first PhD degree about a year earlier than those in the full sample. A much higher proportion of the postdoc sample is in biology (55.7 percent) than in the full sample (33.8 percent). In addition, a slightly higher proportion of the postdoc sample consists of temporary visa holders. These statistics are consistent with what we found in the propensity model in Section 3.

Table 6 also shows that in the postdoc sample, 67.6 percent of the individuals held their most recent postdoc in academe (benchmark), 5.6 percent in industry, 21.8 percent in government and 5.1 percent in other sectors. In terms of the fringe benefits, 81.7 percent of the postdoc sample reported their most recent postdoc positions offered health benefits. However, only 28.1 percent reported their most recent postdoc positions offered pension benefits.

Table 7 reports results from our basic Ordinary Least Square (OLS) model of the total length of an individual's postdoc experience. We include all individuals who received a PhD between 1975 and 1990 and held at least one, but at most three postdoc positions. The dependent variable in this model is the total length of an individual's postdoc experience. The results suggest that the length of an individual's postdoc experience is negatively associated with the age at which an individual received his PhD. However, the estimate is not statistically significant. This indicates that while younger PhDs are more likely to take a postdoc position (as suggested by the results from Section 3), age does not play a significant role in how long individuals spend in postdoc positions after they take a postdoc position.

Personal characteristics play an important role. The results show that those on temporary US visas on average spend 2.4 more months in postdoc positions than US citizens and the estimate is significant. Asians tend to stay in postdoc positions longer than whites (benchmark) and the estimate is statistically significant. Everything else equal, Asians spend about 2.1 months longer in postdoc positions than whites. Blacks on average spend about 2.5 months shorter in postdoc positions than whites. (Note that other races are excluded from the analysis due to their small sample sizes.)

Married individuals on average spend 1.8 months shorter in postdoc than others and the estimate is statistically significant. Postdoc length is negatively associated with the number of dependents (other than spouse) and the estimate is significant. These results are consistent with the theory that postdoc training is considered an investment in additional human capital and individuals with capital constraints are less likely to opt for the investment.

Results also show that field of training matters a great deal. Compared to biology postdocs (benchmark), individuals in other fields spend between 8 to 23 fewer months in postdoc positions, depending on the field. For example, engineers and computer scientists on average spend 23 fewer months in postdoc than biologists; astronomers on average spend about 8 fewer months in postdoc than biologists. The estimates of all field variables are statistically significant at the 0.1 percent level. These results show that not only are biology PhDs more likely to take a postdoc position (as suggested by results from Section 3), they also tend to spend more time in postdoc positions.

The sector in which the most recent postdoc position is held seems to matter somewhat. Compared to those whose most recent postdoc is in academe (benchmark), those whose most recent postdoc is in industry spend 2.4 fewer months in postdoc and the estimate is significant.

The fringe benefits provided by the most recent postdoc position play an important role in the length of an individual's postdoc experience. Everything else equal, those who receive pension benefits stay on a postdoc position 9.3 more months than those who do not have pension benefits. Those who receive health insurance stay on 2.7 more months than those who do not receive health insurance.

The results also show that most PhD year dummy variables (1979 to 1990) are positive and statistically significant (the benchmark is 1975). This suggests that the length of postdoc experience has been rising during the period between 1979 and 1990.

The 1995 SDR postdoc module includes questions on the reasons for taking the postdoc positions. One in eight respondents state that they took the most recent postdoc because other jobs were not available. Although this is clearly a highly subjective measure of labor market conditions, in the absence of other measures we include it in the analysis. We find that those who report “bad jobs” as the reason for having taken the most recent postdoc position hold the position 2.7 months longer than those who do not report this as the reason.

We also estimate a duration model of postdoc length.[13] The duration model allows us to include all postdocs in the analysis while taking into account the fact that some individuals were still on a postdoc position at the time of the 1995 survey (right-censored). In the duration model, the dependent variable is the log of the postdoc length. Results are reported in Columns 1 and 2 in Table 8. To put these results in perspective, we also estimate our OLS model using the log of postdoc length as the dependent variable for the time period 1975-1990 and report the results in Columns 3 and 4. These results show that estimates from the duration model are very similar to those from the OLS model, further confirming that our OLS results are robust.

5 Concluding remarks

US research universities have become increasingly populated by postdoctoral fellows. During the 1990s, for example, the proportion of PhDs on US campuses who were postdocs increased by over 16 percent. This increase is a mixed blessing for research universities. On the one hand, postdocs receive training and contribute to the research productivity of the university. On the other hand, the growing number of postdocs on campuses, coupled with their poor job prospects, has led to considerable dissatisfaction among postdocs. This in turn creates morale problems for laboratories. It can also have negative spillover effects for undergraduates pondering a career in science or engineering.

Here we have examined factors contributing to this increase, paying particular attention to the propensity of individuals to take a postdoc and the amount of time individuals spend in postdoc positions. We find that the increased propensity to take a postdoctoral position can be attributed to a change in the mix of doctoral students, particularly to the increased proportion of PhDs being awarded in the life sciences and the increased proportion of temporary residents in the graduate population. The increased propensity to take a postdoc position also relates to adverse job market conditions experienced by PhDs during the period.

We find that increased duration can be explained by some of the same factors. These include the increasing proportion of temporary residents in the graduate population and the increased number of degrees being awarded in the life sciences. Adverse job market conditions also appear to play a role, although we have a subjective measure of the state of the market. We also find the duration of the postdoc experience to be positively related to the provision of pension and health benefits.

In recent years, as the proportion of the campus community that are postdocs has grown, university administrators have begun to address many of the complex issues related to postdocs. These include length of tenure in position, pay and fringe benefits. It is now becoming somewhat common, for example, for universities to limit tenure in a postdoctoral position to five years, and many universities now provide the fringe benefits that historically were not provided to postdocs. These are fixes that can be made at the university level. The major issue of job market prospects, however, is outside the scope of the local university. Our work suggests that during the late 1990s, when the economy heated up, the propensity to take a postdoc declined. Universities have little direct impact on short-term economic growth. But, they do have the ability to influence the way in which national research funds are distributed and committed. One possible "fix" to the postdoc situation is to use federal funds increasingly to support career positions of research scientists. Gerbi and Garrison (2004) recommend that universities "look beyond the current scheme of graduate students and postdoctorals to staff the academic research laboratory," recognizing the importance of the research scientist's position and rewarding research scientists with salaries that make the position an "honorable career."

Table 1. Postdoctorate Population in Science and Engineering at US Universities, 1987-2001

Year	Total Postdocs	Biological Sciences	Engineering	Physical Sciences	Other
1987	18 771	10 358	1443	4945	2025
1988	19 687	10 667	1685	5185	2150
1989	20 864	11 425	1912	5385	2142
1990	21 770	11 930	1939	5565	2336
1991	22 811	12 478	2243	5693	2397
1992	23 825	13 172	2351	5757	2545
1993	24 611	13 779	2434	5648	2750
1994	25 786	14 469	2589	5810	2918
1995	26 060	14 661	2635	5814	2950
1996	26 489	14 907	2665	5791	3126
1997	27 155	15 096	2964	5897	3198
1998	27 765	15 781	2847	5925	3212
1999	28 874	16 123	3187	6092	3472
2000	30 155	16 764	3309	6202	3880
2001	29 971	16 913	3113	6152	3793

Source: Authors' calculations based on data drawn from various years' Survey of Graduate Students and Postdoctorates in Science and Engineering. Other includes mathematics, computer sciences, agricultural sciences, psychology, and social sciences. Health fields are excluded from counts.

Table 2. Summary Statistics of Explanatory Variables for the Propensity Model, 1981-1999

		Definite Group		Definite or Seeking Group	
Variable Name	Definition	Mean	Standard Deviation	Mean	Standard Deviation
AGE AT PHD	Age	32.585	5.251	32.787	5.262
USCITZ	Equal 1 if US citizen	0.704	0.456	0.663	0.473
USPERM	Equal 1 if permanent resident	0.071	0.257	0.083	0.276
FEMALE	Equal 1 if female	0.254	0.436	0.255	0.436
MARRIED	Equal 1 if married	0.592	0.491	0.587	0.492
AGRI	Equal 1 if degree in agriculture	0.057	0.232	0.064	0.245
PHYS	Equal 1 if degree in physics	0.069	0.254	0.072	0.259
ASTR	Equal 1 if degree in astronomy	0.009	0.097	0.008	0.092
CHEM	Equal 1 if degree in chemistry	0.134	0.341	0.124	0.330
COMP	Equal 1 if degree in computer science	0.039	0.193	0.038	0.191
EART	Equal 1 if degree in earth science or oceanography	0.036	0.185	0.036	0.187
ENGI	Equal 1 if degree in engineering	0.166	0.372	0.180	0.384
MATH	Equal 1 if degree in math	0.055	0.228	0.057	0.233
MEDI	Equal 1 if degree in health or medical field	0.069	0.254	0.068	0.252
USBA	Equal 1 if bachelor’s degree from US institution	0.733	0.442	0.693	0.461
DEPENDS	Number of dependents	0.833	1.191	0.867	1.180
PREFTEMP	Worked full time last year in graduate school	0.288	0.452	0.246	0.430
PREPTEMP	Worked part time last year in graduate school	0.061	0.240	0.077	0.266
PREFELLOW	Had fellowship last year in graduate school	0.580	0.493	0.582	0.493
PREOTHER	Other support last year in graduate school	0.017	0.130	0.019	0.136
TOPAGRI	Equal 1 if from top ten PhD program, agriculture	0.016	0.126	0.018	0.134
TOPPHYS	Equal 1 if from top ten Phd pogram, physics	0.018	0.132	0.016	0.126
TOPBIOL	Equal 1 if from top ten PhD program, biology	0.032	0.175	0.028	0.164
TOPASTR	Equal 1 if from top ten PhD program, astronomy	0.003	0.061	0.003	0.057

TOPCHEM	Equal 1 if from top ten PhD program, chemistry	0.026	0.159	0.021	0.145
TOPCOMP	Equal 1 if from top ten PhD program, computer science	0.010	0.097	0.009	0.093
TOPEART	Equal 1 if from top ten PhD program, earth science /oceanography	0.009	0.095	0.009	0.094
TOPMATH	Equal 1 if from top ten PhD program, math	0.012	0.110	0.011	0.106
TOPMEDI	Equal 1 if from top ten PhD program, medical field	0.011	0.106	0.011	0.104
TOPENGI	Equal 1 if from top ten PhD program, engineering	0.172	0.377	0.183	0.387

Table 3. Logit Model Results for Those Who Received a PhD Between 1981-1999

Dependent variable: Postdoc

	Definite Group					Definite & Seeking Group			
Variable Name	logit coefficient (47.0%)		Standard errors	Odds ratio		logit coefficient (44.7%)		Standard errors	Odds ratio
INTERCEPT	3.705		0.063			2.962		0.050	
AGE AT PHD	-0.061	**	0.001	0.941		-0.055	**	0.001	0.946
USCITZ	-0.611	**	0.032	0.543		-0.536	**	0.024	0.585
USPERM	-0.441	**	0.027	0.643		-0.467	**	0.020	0.628
FEMALE	0.055	**	0.015	1.057		0.258	*	0.012	1.026
MARRIED	-0.135	**	0.014	0.874		-0.108	**	0.011	0.898
AGRI	-1.540	**	0.029	0.214		-1.349	**	0.023	0.260
PHYS	-0.894	**	0.026	0.409		-0.818	**	0.021	0.441
ASTR	-0.385	**	0.073	0.680		-0.248	**	0.061	0.780
CHEM	-1.392	**	0.019	0.320		-0.951	**	0.016	0.386
COMP	-3.369	**	0.049	0.034		-3.006	**	0.039	0.049
EART	-1.392	**	0.035	0.249		-1.111	**	0.028	0.329
ENGI	-1.859	**	0.022	0.156		-1.656	**	0.017	0.191
MATH	-2.735	**	0.034	0.065		-2.397	**	0.026	0.091
MEDI	-1.800	**	0.029	0.165		-1.631	**	0.024	0.196
USBA	-0.392	**	0.031	0.676		-0.409	**	0.024	0.664
DEPENDS	-0.156	**	0.007	0.855		-0.109	**	0.005	0.897
PREFTEMP	-1.066	**	0.028	0.344		-0.576	**	0.020	0.562
PREPTEMP	-0.395	**	0.034	0.674		-0.135	**	0.024	0.874
PREFELLOW	0.079	**	0.027	1.082		0.325	**	0.018	1.385
PREOTHER	0.004		0.052	1.004		0.274	**	0.039	1.315
TOPAGRI	0.057		0.051	1.059		0.040		0.039	1.041
TOPPHYS	0.105	*	0.047	1.110		0.148	**	0.039	1.160
TOPBIOL	0.652	**	0.042	1.919		0.705	**	0.034	2.025
TOPASTR	0.600	**	0.127	1.814		0.440	**	0.106	1.553
TOPCHEM	0.129	**	0.035	1.138		0.187	**	0.032	1.206
TOPCOMP	0.166	*	0.084	1.181		0.181	*	0.071	1.199
TOPEART	0.555	**	0.063	1.743		0.573	**	0.053	1.773

TOPMATH	0.689	**	0.058	1.991		0.607	**	0.049	1.836
TOPMEDI	-0.006		0.066	0.994		0.007		0.055	1.007
TOPENGI	-1.565	**	0.021	0.209		-1.313	**	0.017	0.269
1982	0.067		0.041	1.070		0.065	**	0.035	1.067
1983	0.219	**	0.041	1.245		0.159	**	0.035	1.172
1984	0.384	**	0.041	1.469		0.305	**	0.035	1.356
1985	0.298	**	0.041	1.348		0.272	**	0.035	1.313
1986	0.486	**	0.041	1.626		0.444	**	0.034	1.558
1987	0.646	**	0.041	1.908		0.540	**	0.034	1.717
1988	0.678	**	0.040	1.969		0.588	**	0.034	1.800
1989	0.601	**	0.040	1.825		0.536	**	0.033	1.708
1990	0.672	**	0.039	1.957		0.623	**	0.033	1.865
1991	0.698	**	0.039	2.010		0.626	**	0.033	1.870
1992	0.827	**	0.039	2.286		0.715	**	0.033	2.045
1993	0.916	**	0.040	2.500		0.802	**	0.033	2.229
1994	0.981	**	0.039	2.666		0.836	**	0.032	2.306
1995	0.964	**	0.039	2.623		0.758	**	0.032	2.133
1996	0.661	**	0.038	1.937		0.505	**	0.031	1.656
1997	0.413	**	0.038	1.512		0.263	**	0.032	1.301
1998	0.412	**	0.038	1.510		0.297	**	0.032	1.345
1999	0.581	**	0.038	1.788		0.461	**	0.032	1.586
Likelihood ratio	61 208					66 443			
Number of observations	171 569					240 866			

** indicates that the estimate is significant at the 0.01 level.

* indicates that the estimate is significant at the 0.05 level.

Table 4. Logit Results for Those Who Received a PhD Between 1981-1995

Dependent variable: Academic Postdoc (32.9%)				
Indepdent Variables	Coefficient		Standard Error	Odds Ratio
INTERCEPT	2.653	**	0.073	
AGE AT PHD	-0.051	**	0.002	0.950
USCITZ	-0.669	**	0.039	0.512
USPERM	-0.677	**	0.034	0.508
FEMALE	0.010		0.017	1.010
MARRIED	-0.064	**	0.016	0.938
AGRI	-1.218	**	0.036	0.296
PHYS	-0.832	**	0.030	0.435
ASTR	-0.851	**	0.084	0.427
CHEM	-0.864	**	0.021	0.422
COMP	-2.856	**	0.072	0.058
EART	-1.310	**	0.045	0.270
ENGI	-1.583	**	0.030	0.205
MATH	-2.268	**	0.045	0.104
MEDI	-1.442	**	0.037	0.236
USBA	-0.250	**	0.038	0.779
DEPENDS	-0.015	**	0.008	0.857
PREFTEMP	-0.693	**	0.032	0.500
PREPTEMP	-0.262	**	0.040	0.770
PREFELLOW	0.114	*	0.029	1.121
PREOTHER	-0.128		0.057	0.770
TOPAGRI	0.076		0.064	1.079
TOPPHYS	0.040		0.051	1.040
TOPBIOL	0.351	**	0.036	1.421
TOPASTR	0.445	**	0.127	1.561
TOPCHEM	0.159	**	0.039	1.172
TOPCOMP	0.209		0.119	1.232
TOPEART	0.521	**	0.076	1.683
TOPMATH	0.649	**	0.075	1.914
TOPMEDI	-0.093		0.090	0.911

TOPENGI	-1.375	**	0.028	0.253
1982	0.024		0.041	1.024
1983	0.104	**	0.041	1.110
1984	0.217	**	0.041	1.243
1985	0.100	**	0.041	1.105
1986	0.232	**	0.040	1.261
1987	0.300	**	0.040	1.349
1988	0.328	**	0.039	1.389
1989	0.250	**	0.039	1.284
1990	0.011		0.040	1.011
1991	0.030		0.039	1.030
1992	0.152	**	0.039	1.164
1993	0.249	**	0.039	1.283
1994	0.247	**	0.039	1.280
1995	0.290	**	0.039	1.336
Likelihood ratio	27 215			
Number of observations	123 497			

** indicates that the estimate is significant at the 0.01 level.

* indicates that the estimate is significant at the 0.05 level.

Table 5. Relationship of Taking a Postdoc Position to Number of PhDs in Cohort by Field, 1981-1995

Field	Postdoc position, any sector	Posdoc position, academe
Biology	+**	-**
Chemistry	-*	-
Physics	+**	+*
Computer science	+**	+**
Engineering, any field	+**	+**
Earth science and oceanography	+**	+**
Math	+**	+**
Agriculture	+**	+
Astronomy	+**	-
Medical fields	+**	+*

** indicates that the estimate is significant at the 0.01 level.
* indicates that the estimate is significant at the 0.05 level.
See text for detailed explanation.

Table 6. Summary Statistics for the Full Sample and Postdoc Sample, SDR 1975-1990

		Full Sample		Postdoc Sample	
		(Sample size: 11,620)		(Sample size: 5,008)	
Independent Variables	Definition	Mean	Standard Deviation	Mean	Standard Deviation
AGE AT PHD	Respondent's age when received the first Ph.D.	31.434	5.004	30.273	3.810
ASIAN	Respondent is Asian	0.171	0.377	0.167	0.373
BLACK	Respondent is Black	0.044	0.205	0.037	0.188
USTEMP	Temporary US resident	0.111	0.314	0.115	0.319
USPERM	Permanent US resident	0.055	0.227	0.042	0.200
FEMALE	Respondent is female	0.240	0.427	0.264	0.441
MARRIED	Respondent is married	0.616	0.486	0.556	0.497
DEPEND	Number of dependents	0.906	1.185	0.659	0.994
AGRI	Agriculture	0.041	0.199	0.030	0.171
MEDI	Medical or health	0.078	0.268	0.038	0.190
7ENGI	Engineering	0.251	0.434	0.097	0.296
COMP	Computer sciences	0.022	0.148	0.004	0.066
MATH	Mathematics	0.051	0.221	0.023	0.149
ASTR	Astronomy	0.008	0.091	0.014	0.117
EART	Earth sciences	0.036	0.187	0.032	0.175
CHEM	Chemistry	0.104	0.306	0.120	0.325
PHYS	Physics	0.070	0.255	0.085	0.280
BIOL	Biology (benchmark)	0.338	0.473	0.557	0.497
PENSION	Most recent postdoc provided pension benefits	—	—	0.281	0.449
HEALTH	Most recent postdoc provided health benefits	—	—	0.817	0.387
BADJOBS	Reason for taking most recent postdocs was other jobs not available	—	—	0.124	0.330
INDUSTRY	Most recent postdoc was in industry	—	—	0.056	0.229
GOVT	Most recent postdoc was in government	—	—	0.218	0.413
OTHER SECTOR	Most recent postdoc was in other sector	—	—	0.051	0.220

1976	Respondent received first Ph.D. in 1966	0.048	0.213	0.054	0.225
1977		0.045	0.208	0.046	0.209
1978		0.047	0.211	0.049	0.215
1979		0.047	0.212	0.053	0.224
1980		0.044	0.206	0.043	0.203
1981		0.049	0.217	0.052	0.222
1982		0.051	0.220	0.057	0.231
1983		0.055	0.227	0.059	0.236
1984		0.063	0.242	0.063	0.243
1985		0.072	0.258	0.068	0.252
1986		0.074	0.261	0.069	0.254
1987		0.083	0.275	0.080	0.272
1988		0.090	0.286	0.079	0.270
1989		0.091	0.288	0.088	0.284
1990		0.091	0.288	0.094	0.292

Table 7. OLS Regression Results of Postdoc Length Model, 1975–1990 PhD Cohorts
Dependent Variable: Postdoc Length

Independent Variables	Coefficient	Standard Error	Pr > | t |
	Column 1	Column 2	Column 3
INTERCEPT	40.303	2.877	<.0001
AGE AT PHD	-0.104	0.085	0.219
ASIAN	2.093	0.990	0.035
BLACK	-2.450	1.583	0.122
USTEMP	2.423	1.153	0.036
USPERM	-1.357	1.569	0.387
FEMALE	-0.591	0.709	0.404
MARRIED	-1.789	0.708	0.012
DEPEND	-1.176	0.378	0.002
AGRI	-15.108	1.751	<.0001
MEDI	-14.758	1.580	<.0001
ENGI	-23.190	1.085	<.0001
COMP	-23.419	4.410	<.0001
MATH	-18.407	1.988	<.0001
ASTR	-8.159	2.515	0.001
EART	-16.993	1.691	<.0001
CHEM	-14.323	0.946	<.0001
PHYS	-11.157	1.096	<.0001
PENSION	9.290	0.676	<.0001
HEALTH	2.722	0.783	0.001
BADJOBS	2.692	0.907	0.003
INDUSTRY	-2.441	1.288	0.058
GOVT	0.229	0.724	0.752
OTHER SECTOR	1.797	1.342	0.181
1976	-0.662	1.855	0.721
1977	-2.112	1.925	0.273
1978	-2.494	1.902	0.190
1979	1.645	1.866	0.378
1980	9.402	3.232	0.171
1981	11.233	3.158	0.005

1982	11.082	3.150	0.029
1983	8.204	3.138	0.223
1984	10.008	3.116	0.014
1985	9.817	3.077	0.045
1986	7.382	3.056	0.021
1987	7.849	3.022	0.093
1988	6.390	3.025	0.179
1989	6.448	2.997	0.122
1990	3.553	2.988	0.795
Dependent Mean (months)	35.8		
Number of observations	5,008		
R-square	0.190		

Table 8. Duration and OLS Regression Results
Dependent Variable: Log of Postdoc Length

	Duration Model			OLS Model	
	1975-1990 PhD Cohorts			1975-1990 PhD Cohorts	
	Coefficient	Standard Error		Coefficient	Standard Error
Independent Variables	Column 1	Column 2		Column 3	Column 4
INTERCEPT	3.713	0.085		3.561	0.090
AGE AT PHD	0.000	0.003		-0.006	0.003
ASIAN	0.086	0.029		0.039	0.031
BLACK	-0.079	0.046		-0.134	0.050
USTEMP	0.069	0.034		0.104	0.036
USPERM	-0.050	0.045		-0.032	0.049
FEMALE	-0.008	0.020		-0.022	0.022
MARRIED	-0.059	0.020		-0.037	0.022
DEPEND	-0.032	0.011		-0.040	0.012
AGRI	-0.405	0.051		-0.507	0.055
MEDI	-0.419	0.045		-0.458	0.049
ENGI	-0.762	0.031		-0.861	0.034
COMP	-0.840	0.125		-0.934	0.138
MATH	-0.527	0.057		-0.618	0.062
ASTR	-0.266	0.071		-0.180	0.079
EART	-0.478	0.049		-0.603	0.053
CHEM	-0.405	0.027		-0.448	0.030
PHYS	-0.314	0.032		-0.345	0.034
PENSION	0.283	0.020		0.239	0.021
HEALTH	0.080	0.022		0.174	0.024
BADJOBS	0.140	0.027		0.003	0.028
INDUSTRY	-0.035	0.037		-0.063	0.040
GOVT	0.008	0.021		0.009	0.023
OTHER SECTOR	0.030	0.039		0.024	0.042
1976	-0.029	0.052		-0.030	0.058
1977	-0.022	0.054		-0.092	0.060
1978	-0.100	0.053		-0.091	0.060
1979	0.064	0.052		0.006	0.058

1980	0.076	0.055		0.050	0.061
1981	0.137	0.053		0.118	0.059
1982	0.081	0.051		0.094	0.058
1983	0.012	0.051		0.050	0.057
1984	0.131	0.051		0.108	0.057
1985	0.081	0.050		0.078	0.056
1986	0.107	0.050		0.122	0.056
1987	0.100	0.049		0.090	0.054
1988	0.084	0.049		0.071	0.054
1989	0.127	0.049		0.106	0.053
1990	0.084	0.049		0.018	0.053

For the duration model, the total number of observations is 5006 (4698 non-censored).

For the OLS model, the number of observation is 5008.

Figure 1. Median Length (in Months) of Postdoc Experience for Ten Fields by PhD Year

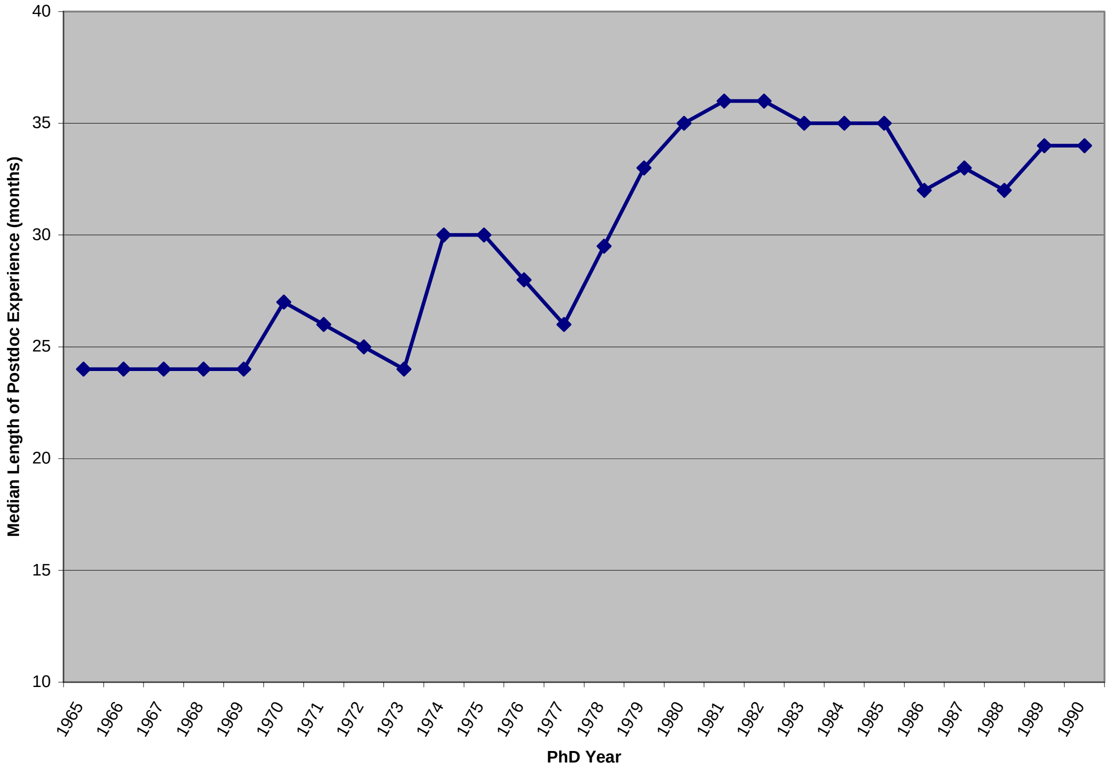


Figure 2. Median Length (in Months) of Postdoc Experience by Field For Those Who Received a PhD Between 1965 and 1990

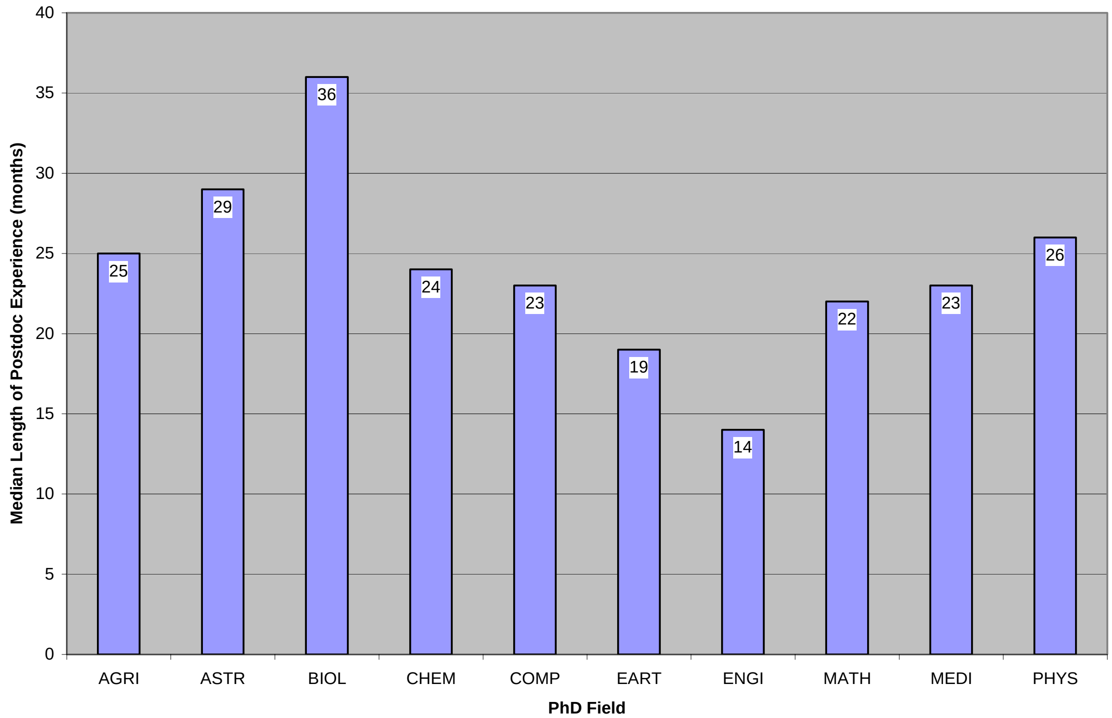
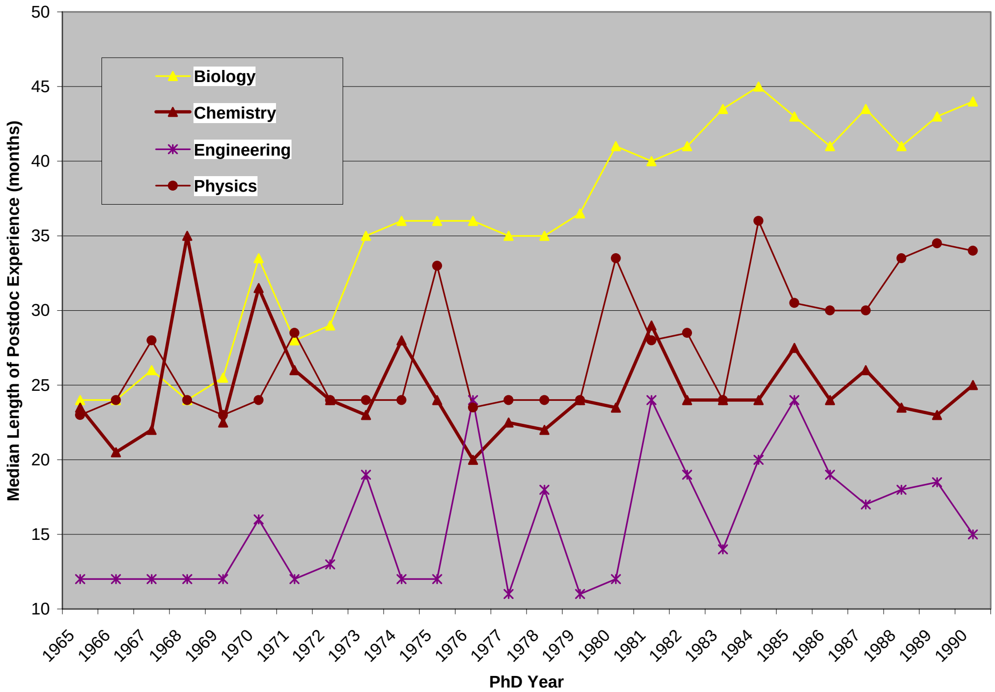


Figure 3. Median Length (in Months) of Postdoc Experience for Four Fields by PhD Year



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[1] Source: National Science Foundation, Graduate Students and Postdoctorates in Science and Engineering: Fall 2001, Table 46.
[2] Source: National Science Foundation, Graduate Students and Postdoctorates in Science and Engineering: Fall 2001, Table 48. Postdoctoral positions in health fields are excluded because many of these positions are held by MDs working in clinical fields.
[3] Slightly more than 72 percent of all postdoctoral appointees (excluding those in health fields) in 2001 were supported by federal funds. Among those on federal support, 80% were supported by research grants. Source: National Science Foundation, Graduate Students and Postdoctorates in Science and Engineering: Fall 2001, Table 47.
[4] Source: Authors' calculations based on data from the 1995 Survey of Doctorate Recipients.
[5] Source: Authors' calculations based on data from various years' Survey of Doctorate Recipients.
[6] The GSS survey includes the following fields: physical sciences, earth, atmosphere, and ocean sciences, mathematical sciences, computer sciences, agricultural sciences, biological sciences, psychology, social sciences, engineering, and health fields. Health fields are excluded from the calculations.
[7] Sources: National Science Foundation, Graduate Students and Postdoctorates in Science and Engineering: Fall 2001, Table 47 and National Science Foundation, Graduate Students and Postdoctorates in Science and Engineering: Fall 1998, Table 48. Postdoctoral positions in health fields are excluded from the calculations.
[8] For a quantitative variable, if we subtract 1.0 from the odds-ratio and multiply by 100, the resulting number can be interpreted as the percentage change in the odds for each unit increase in the independent variable.
[9] A top program in a given field is defined as one ranked in the top-ten based on the National Research Council's 1993 ranking of scholarly quality for all fields except agriculture and medicine. A top program in these two fields is defined as being among the top-ten institutions for federally funded R&D expenditures in the given field. For our fields that are more broadly defined than the NRC program definitions, such as biology, our rankings are based on the mean of all NRC-rated programs at an institution that fall under our field definition.
[10] We consistently found the non-linear term "age-squared" to be insignificant and thus use only the variable "age."
[11] The sample is restricted to those with definite plans.
[12] Data are taken from www.aaas.org/spp/rd/hist04c.pdf.
[13] Our duration model is estimated using the Lifereg procedure in SAS.