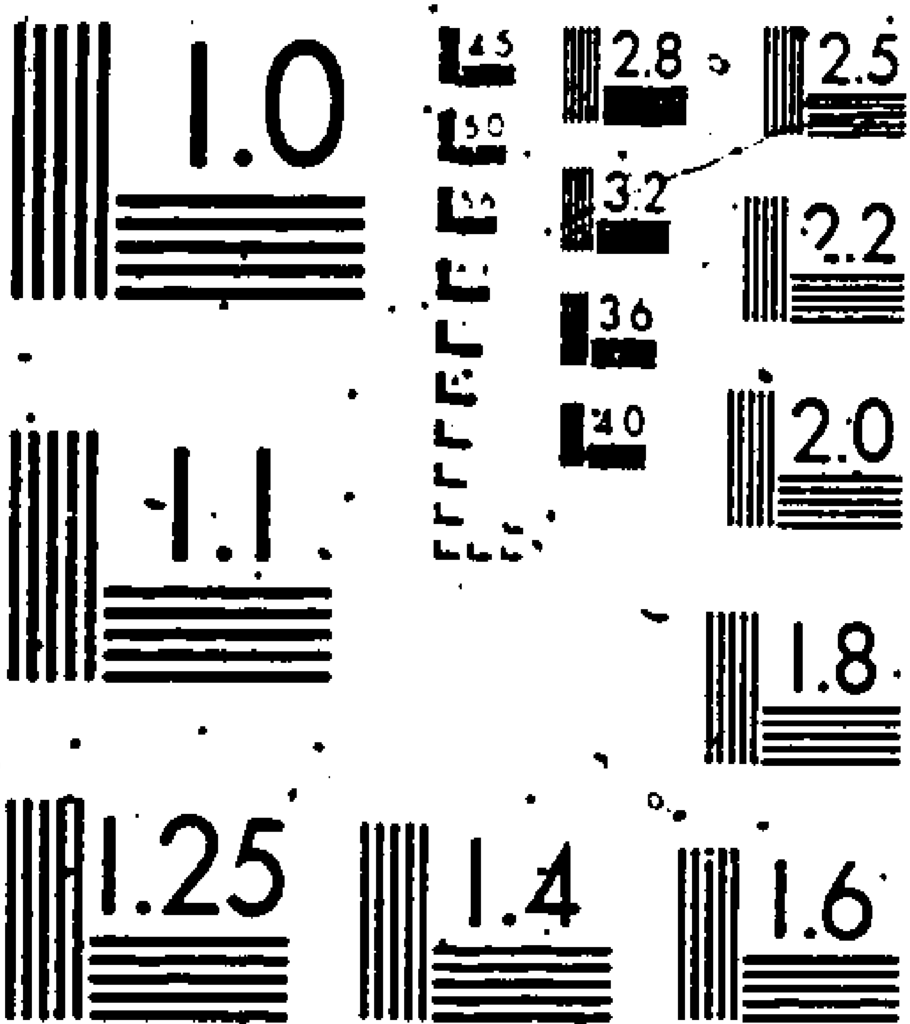

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ABSTRACT

The outcomes of the employment situation for science and engineering PhDs were assessed through a survey of college and university departments and faculty members who had accepted new academic jobs or who had left academic jobs for other positions within the last three years. Faculty members who had accepted their first job after receiving the doctorate were not included. A large sample of PhDs in 12 fields who were employed by the federal government and PhDs in many fields who were employed outside academe or government were also surveyed. The study analyzed the responses to an eight-page questionnaire, completed by 10,000 doctorate holders, which dealt with career outcomes, current job characteristics, personal and educational backgrounds, and career histories. Findings are reported on three important career outcomes: salary, job satisfaction, and publication rates. Detailed multivariate analyses were conducted on the three dependent variables and the following six categories of independent variables: background factors, educational experience, present job characteristics, employment history, satisfaction with life in general and with leisure activities, and mobility. It appears that salary, publication, and relationship of job to graduate study are important determinants of job satisfaction, although publication affects satisfaction only because it relates to salary. It is concluded that academic jobs are not the only desirable jobs for science and engineering PhDs, and that the decline in academic jobs does not warrant cutbacks in science and engineering. Maintenance of PhD production need not result in less satisfying or less productive jobs. (SW)

The Labor Market for PhDs in Science and Engineering: Career Outcomes*

by

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The National Science Foundation (NSF) has estimated that between 375,000 and 400,000 science and engineering doctorates will be available in 1985, compared with about 295,000 available positions. These projections indicate a trend toward increasing imbalances between supply and utilization, which could mean that many doctorates will not find jobs in science and engineering fields and some may be unemployed. The magnitude of the unemployment is difficult to project, but it is expected to be relatively small, since doctorate holders unable to find related or traditional jobs are still likely to find some sort of employment (NSF, 1975).

Between 1972 and 1985, NSF has estimated a surplus of 78,000 science and engineering PhDs. The Bureau of Labor Statistics (1975) has projected the surplus at 190,700 over the same period. Although there have been a number of criticisms of the bureau's approach, the two sets of projections do provide boundaries for the possible surplus (Cangialosi 1976).

To help policymakers and planners deal with this projected surplus, the Higher Education Research Institute (HERI) is conducting a study of nonacademically employed science and engineering doctorate holders and faculty members who have changed jobs during the past three years. It is important to understand the determinants of job satisfaction and productivity to evaluate the efficacy of continued production of PhDs when the number of traditional science and engineering jobs is declining. If PhDs employed in jobs that are not generally associated with their fields are satisfied and productive, then the move toward

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nontraditional careers for new doctorates may be socially beneficial. However, if doctorates are forced into unsatisfying jobs--perhaps those in which they are unable to conduct research--the nation's resources will be underutilized and many highly educated workers will be discontent. It is also important to understand mobility patterns of science and engineering doctorate holders, since an important source of academic jobs during a period of declining enrollments is created when faculty members move to other employment sectors.

Methodology

The HERI study identified through a survey of college and university departments, faculty members who had accepted new academic jobs or who had left academic jobs for other positions within the last three years. Faculty members who had accepted their first job after receiving the doctorate were not included in the resulting roster. With cooperation from the federal Civil Service Commission, the study was also able to survey a large sample of PhDs employed by the federal government: all those in nine specific fields (anthropology, chemistry, economics, mathematics, physics, political science, sociology, civil engineering, and mechanical engineering) and random samples of those with degrees in biological sciences, psychology, and electrical engineering. The last three fields were sampled because the roster included many PhDs from these fields who were employed outside government. The number of PhDs in the government in these three fields was also large. Professional societies were able to add to the roster PhDs from many fields who were employed outside academe or government. The response rate from a survey of a roster of more than 19,000 science and engineering doctorates was over 50%.

This study includes the largest number of nonacademically employed science and engineering doctorate holders ever analyzed. In contrast, the Comprehensive Roster of the National Research Council (NRC) includes only about 2,000 such PhDs who are employed "outside science," presumably in jobs which are nontraditional for PhDs. The periodic faculty surveys sponsored by the Carnegie Commission on Higher Education, focused only on faculty members, excluding nonacademically employed PhDs. Hence, despite the unusual way the original roster was compiled, it can be assumed that the sample is sufficiently representative to provide useful information on science and engineering doctorate holders outside academe and on those who have moved in or out of colleges and universities in recent years.

The study analyzed the responses to an eight-page questionnaire, completed by 10,000 doctorate holders, which dealt with career outcomes, current job characteristics, personal and educational backgrounds, and career histories. This paper focuses on three important career outcomes: salary, job satisfaction, and publication rates, a proxy for productivity. To determine publication rates, a publication index was developed to weigh different types of publications. The weights were assigned as follows: scholarly books, single authorship, 10; scholarly books, joint authorship, 6; edited books, 5; other books, 6; chapters or articles in scholarly journals, 3; articles in nonscholarly journals, 2; book reviews, editorials, abstracts, other published short works, 1; published reports, 3; unpublished reports of article or monograph length, 1; patentable inventions, 4. The numbers were added to get the publication index.

Knowledge about jobs that provide acceptable salaries, satisfaction and opportunities to publish will help determine whether PhDs in science and engineering will be able to pursue satisfying and productive--although nontraditional--careers in the face of scarce traditional job openings.

Six categories of factors are associated with the three dependent variables. Before turning to detailed multivariate analyses however, it is useful to understand the reasons for including certain independent variables and the distribution of responses to certain questions. Table 1 provides basic data by field and employment sector.

Insert Table 1 here

The first group of independent variables represents background factors: sex, age, and marital status. It is clear that mobile faculty members--those who moved into new faculty jobs within the past three years--are younger than doctorates employed in government or industry. Many young faculty probably change employer about the time of the tenure decision.

The second set of variables represents educational experience. Various PhD fields were included as dichotomous variables to see whether differences in field affect the outcomes. Selectivity of graduate institution and rank in class were also included. Finally, years since PhD was included for a number of reasons. Clearly, time in the labor force will affect career outcomes. However, two variables highly related to years since PhD--age and the number of years of full-time employment--were also included. Since a stepwise regression technique was used in some analyses, in the final step only the variables with the greatest independent correlation with the dependent variables remained significant.

It has been argued that those who received their PhD at an earlier age are more able or more motivated than others. By including both age and years since PhD, the analyses revealed the separate effects of receiving the PhD at a relatively early age and of age itself on career development.

It is also argued that one reason men and women who receive their PhDs at the same time experience different career outcomes is that women spend fewer postgraduate years in the labor force. Controlling for years since PhD and

Background Data by Field and Employment Sector

Basic Data	Biology Faculty	Biology Government	Biology Other	Chemistry Faculty	Chemistry Government	Chemistry Other	Physics Faculty	Physics Government	Physics Other
Number of cases	266	823	90	124	772	181	182	525	173
Mean salary	19,300	30,100	26,500	20,000	31,400	34,200	18,800	33,100	35,900
Mean year of PhD	69.3	62.9	64.0	68.3	61.1	60.6	69.7	63.6	57.2
Percentage same field job/PhD	87.5	88.5	79.2	89.7	72.9	71.2	92.5	66.9	47.5
Percentage in job closely related to PhD	85.4	68.9	50.8	86.4	49.5	46.8	82.9	43.9	31.2
Reason not in closely related job									
Percentage voluntary	45.8	54.9	45.0	64.5	44.5	72.9	36.5	44.3	66.4
Percentage involuntary	10.8	5.2	5.0	0.0	7.6	1.9	6.2	6.6	3.1
Percentage both	43.4	39.9	50.0	35.5	47.9	25.2	57.3	49.1	30.5
Percentage not underemployed	74.9	71.2	60.7	80.5	66.6	75.5	85.7	68.4	76.2

Basic Data	Mathematics Faculty	Mathematics Government	Mathematics Other	Civil Engineering Faculty	Civil Engineering Government	Civil Engineering Other	Electrical Engineering Faculty	Electrical Engineering Government
Number of cases	227	199	74	80	92	36	57	230
Mean salary	17,400	31,100	25,600	22,300	30,800	30,800	24,400	33,300
Mean year of PhD	70.2	65.3	67.0	70.8	68.3	66.9	68.5	66.4
Percentage same field job/PhD	96.1	78.5	61.3	97.7	85.2	85.0	93.6	82.3
Percentage in job closely related to PhD	85.2	44.1	32.9	94.0	77.6	79.0	79.1	49.8
Reason not in closely related job								
Percentage voluntary	27.9	40.3	50.0	50.0	71.7	87.5	67.2	65.2
Percentage involuntary	15.6	6.3	5.8	0.0	14.1	0.0	0.0	4.6
Percentage both	56.6	53.4	44.2	50.0	14.1	12.5	32.8	30.3
Percentage not underemployed	74.6	55.3	60.5	77.1	71.1	67.5	75.2	55.8

	Mechanical Engineering Faculty	Mechanical Engineering Government	Mechanical Engineering Other	Economics Faculty	Economics Government	Economics Other	Political Science Faculty	Political Science Government	Political Science Other
Number of cases	93	124	43	181	218	57	139	85	31
Mean salary	22,000	31,600	36,100	22,700	33,900	32,500	18,700	32,300	26,200
Mean year of PhD	69.8	68.1	63.0	69.7	67.5	67.0	70.5	65.2	69.0
Percent same field job/PhD	85.2	84.4	70.8	96.3	94.6	91.0	97.4	74.9	82.0
Percent in job closely related to PhD	80.0	60.0	53.5	96.7	77.6	72.9	88.5	43.2	48.6
Why not in closely related job									
Percent voluntary reasons	70.1	46.7	73.7	66.7	63.3	63.2	51.1	52.3	70.6
Percent involuntary reasons	5.2	11.1	5.3	16.7	12.2	10.4	17.8	4.5	5.8
Percent both	24.7	42.2	21.[illegible]	16.7	24.5	26.3	31.1	43.2	23.5
Percent not underemployed	77.4	59.9	67.5	82.6	66.4	79.4	79.7	63.5	68.6

	Anthropology Faculty	Anthropology Government	Anthropology Other	Psychology Faculty	Psychology Government	Psychology Other	Sociology Faculty	Sociology Government
Number of cases	237	42	56	434	538	705	140	59
Mean salary	15,800	23,300	15,100	23,300	29,400	26,800	19,400	29,600
Mean year of PhD	72.2	70.8	70.8	65.3	63.5	64.1	70.3	66.1
Percent same field job/PhD	93.4	76.7	87.3	92.8	92.4	92.4	92.3	86.2
Percent in job closely related to PhD	89.8	56.3	64.5	78.4	67.8	68.2	92.7	59.3
Why not in closely related job								
Percent voluntary reasons	30.6	37.5	34.6	56.1	61.0	71.5	63.6	61.7
Percent involuntary reasons	11.5	0.0	3.6	0.0	4.8	4.5	9.1	8.5
Percent both	57.7	61.8	61.8	43.9	34.2	24.0	27.3	29.8
Percent not underemployed	63.2	68.2	57.7	73.0	65.3	69.2	75.9	60.3

years employed full time since PhD indicates whether differences between men and women are a function of sex itself or of differential years of experience for a given number of years since the PhD.

The third set of independent variables considers characteristics of the present job. In this category, 12 dummy variables categorized individuals according to whether they were employed in colleges and universities; government, or the private sector (designated "other"), and also whether they were teaching, conducting research, working in administration, or working primarily at "other" things. With the three employment sector categories and the four primary work activity categories, each individual could be placed in one of 12 sector/work activity cells. The regressions determined whether these categories are related to career outcomes.

Jobs can also be evaluated by their "relatedness" to the graduate specialization. Do PhDs working in their field earn more because they are more competent? Or is relatedness a proxy for "faculty," who teach what they were taught. About 90% of faculty respondents work in their PhD field (Table 1). Of those employed in government, economists (85%), psychologists (92%), and biologists (89%) are most likely to work in their PhD field. Physicists in government are least likely to be employed in their PhD field (67%). Economists and psychologists are most likely to continue working in their PhD field while employed in industry, while physicists, again, are least likely to do so. Despite the time since graduation for nonacademics, a large number still feel they work in their PhD field. Yet the percep- of the relatedness between job and PhD training is much lower for nonacademic n for faculty members, especially for nonacademics working in the private sector. Regardless of sector, only 10% of PhDs who hold unrelated jobs indicated that they do so involuntarily; most hold them because they prefer their unrelated jobs over more closely related alternatives. Strikingly, in most fields, science and engineering PhDs are most likely to say they are underemployed if they work in government.

Other characteristics of the present job included in the regressions were: whether an individual is working full time, the percentage of time devoted to the primary job, the number of years on the job, whether the respondent perceives the job as nontraditional, and whether the respondent is now doing research. Salary was included in the job satisfaction regression; the publication index was included in both the other regressions.

The fourth category of explanatory variables represents employment history. The purpose here was to see if career outcomes are affected by whether or not the doctorates were employed between their BA and PhD, the number of jobs they have held, whether they have changed their career goals, the number of years they have been employed full time since their PhD, and whether they were seeking a job while on their previous job.

Next, the extent of the correlation between career outcomes and satisfaction with life in general and with leisure activities was examined in the job satisfaction regression. Table 2 shows satisfaction with life in general and with future

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Insert Table 2 here

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prospects for respondents in different fields and employment sectors. Other studies (Solmon & Ochsner, 1978) indicate a strong correlation between life satisfaction and job satisfaction, implying that the causation runs from the latter to the former. In all fields except electrical engineering, those employed in industry are more satisfied with life than faculty members; government workers in all fields except civil and electrical engineering, economics, and political science are also more satisfied than faculty. Except for anthropologists and biologists, those employed in industry are more satisfied with life in general than are those

Table 2

Satisfaction with Life and Future Prospects, by Field and Employment Sector

(in percentages)

Field	Life			Future		
	Faculty	Government	Other	Faculty	Government	Other
Biology	60.0	65.4	64.2	43.3	46.4	44.0
Chemistry	54.5	58.9	60.2	41.8	34.4	48.5
Physics	53.7	56.1	63.9	31.0	34.6	47.7
Mathematics	50.7	54.1	57.3	29.7	38.8	43.2
Civil engineering	63.5	61.6	70.0	50.8	40.5	66.7
Electrical engineering	67.6	57.3	36.0	66.7	35.3	52.9
Mechanical engineering	59.6	60.4	77.3	52.3	33.1	70.5
Economics	58.9	58.0	71.0	47.4	44.1	53.0
Political science	59.6	58.1	58.8	47.8	36.7	53.1
Anthropology	51.4	65.9	53.1	41.3	48.8	34.1
Psychology	56.7	60.9	66.4	43.7	47.2	53.6
Sociology	60.6	64.8	59.7	53.8	47.5	53.0

Note. Percentages indicate "very satisfied."

employed in government. This fact and the greater sense of underemployment of government workers emphasizes the positive relationship between job satisfaction and life satisfaction. Academics are less satisfied with future prospects than those employed in industry, but they tend to be more satisfied than those employed in government. Since the faculty members in the sample were young and mobile, they may have different views than their older, less mobile counterparts. Future academics, however, would probably experience the same insecurities as the faculty in this sample. The respondents indicated that nonacademic employment would not be such a bad, albeit unrelated, career choice.

Since satisfaction with future prospects is highly correlated with job satisfaction, the former was omitted from the job satisfaction regressions. Both job satisfaction and satisfaction with leisure are said to be components of life satisfaction; hence, attitudes about leisure and life were included to discern the correlations between each of these and job satisfaction after holding constant other factors.

Finally, there were four measures of mobility: whether respondents would look nationwide if seeking a new job, whether climate places a constraint on the type of jobs considered, whether spouse's job preferences restrict mobility, and the location of the job in terms of miles from the town in which a person grew up. These mobility indicators tested the hypothesis that those who are more geographically mobile should be better able to achieve satisfactory career outcomes.

As Table 3 indicates, a large number of mobility measures were available from

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Insert Table 3 here

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the survey. The three in the regression represented diverse types of attitudes about willingness (would look nationwide and importance of climate) and ability (spouse's job) to move. An indication of actual mobility to date (miles from home

Table 3

Attitudes Toward Mobility and Location, by Sex and Employment Sector

(in percentages)

	Mobility Measure	Men			Women		
		Faculty	Government	Other	Faculty	Government	Other
(+)	I would take a job anywhere as long as there were opportunities to travel	4.4	2.8	3.4	4.6	4.8	5.2
(+)	If I were looking for a job now, I would look nationwide	41.7	28.4	28.2	29.9	19.9	19.2
(-)	There are a limited number of cities in which I would live	40.4	43.0	48.6	41.3	46.6	47.7
(-)	Climate would be a major factor in my decision to move	20.4	24.5	28.7	16.1	16.8	26.6
(+)	I would take a job anywhere for a short period but I have specific preferences for permanent residence	19.3	18.5	18.1	17.4	16.7	19.5
(+)	I would move anywhere if the salary were attractive enough	8.7	8.4	8.7	2.4	6.0	7.3
(+)	I would move anywhere for an extremely satisfying job	26.5	22.5	21.2	24.0	20.5	20.7
(-)	I will be more mobile when my children are out of school	15.6	18.5	18.1	11.7	14.5	16.0
(-)	My mobility is limited because my parents are alive	1.9	2.0	2.2	4.5	4.2	4.0
(-)	My ideal job location is within 500 miles of the community where I grew up	8.9	7.5	7.6	12.0	8.6	7.8
(-)	My occupation severely limits my choice of geographic location	9.2	12.7	7.9	6.4	7.8	7.3
(-)	My mobility is limited because of spouse's job	4.4	3.7	3.8	35.5	30.0	31.2
(-)	My mobility is limited because of spouse's educational plans	1.4	0.9	1.2	2.9	3.5	3.0
(-)	My mobility is limited because of spouse's preferences about locale	6.7	7.0	8.[illegible]	13.3	11.5	15.5
	Mobility index	-8.3	-39.2	-46.7	-65.4	-75.8	-87.2

Note. Percentages indicate "strong agreement" among all fields.

town to present job) was also used, although for women this could be a function of spouse's mobility. Table 3 shows the attitudes of male and female PhDs separately, according to whether their present job is in an academic, government, or industrial setting. That salary attracts faculty less than location is immediately evident. It is also clear that women are more limited by their spouses than men, regardless of sector. The group most motivated by salary is economists.

A crude mobility index was constructed by making an arbitrary decision that five statements indicate mobility and the remainder indicate limited mobility or immobility.* Women are much less mobile than men, faculty members are the most mobile of all, even though most have already moved within the last three years. They are followed by government, then industrial, employees.

Faculty members may be willing to increase their mobility in an effort to hold a "related" job, that is, teaching in their field. Yet Tables 1 and 2 suggest that the payoffs for faculty must come in terms other than salary and life satisfaction. The multivariate analyses provide the controls necessary to clarify the role of relatedness in career outcomes.

Results of Stepwise Linear Regressions

The stepwise multiple regression technique was not used here to test a causal model, but rather to find correlates with career outcomes. In certain cases,

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*The proportion of statements indicating strong agreement for male faculty members, government employees, and so on, was summed, with the factors indicating mobility given a plus sign and those indicating immobility given a minus sign. Hence, if a group--say male faculty members--was perfectly mobile, the score would be plus 500 because 100 percent of male faculty members would have indicated strong agreement with the five positive factors and zero percent would have indicated strong agreement with the negative factor. Similarly, if a group were perfectly immobile, the index would be minus 900 because zero percent would have indicated strong agreement with the positive factors and 100 percent would have indicated strong agreement with each negative factor. Thus, a category that was neutral vis-a-vis mobility, that is, a category in which 50 percent are in strong agreement with each of the statements, would have an index of minus 200. The fact that each of the columns indicates a negative mobility index does not mean immobility. All indices shown are above minus 200.

significant final beta coefficients lead to inferences about direction of causation. But the major purpose of the regression analyses was to identify significant partial correlations and to determine the extent to which career outcomes can be predicted by this rather comprehensive and intuitively logical set of factors.

Current Salary

The standard human capital earnings function explains earnings by years of schooling and years in the labor force, among other things. Since all respondents achieved the PhD, years of schooling was not included in the equation (Table 4).

Insert Table 4 here

However, both years on the present job and total years worked since the PhD were included and were significant in the final step. Both general and specific on-the-job training have a payoff to the PhD. The normalized coefficients on total years employed is about twice as large as the coefficient for years on current job. Those who worked between the time they received the BA and the PhD also earn more. The additional experience might add to their earning power, or those who interrupted their education to work might earn more money because they have greater motivation.

Clearly, "total years worked" is highly correlated with age (r = .830) and age is highly correlated with income (r = .488), but the age-income relationship is not significant in the final steps of the regression. The simple correlation between years since PhD and income (r = .544) is higher than the correlation between age and income and, despite the significance of total years worked, years since PhD is also significant in the final step. This implies that the greater the number of years employed since receipt of the PhD, the higher the income.

A common explanation of wage differences between men and women of the same age is that women leave the labor force to raise children. Yet, the regression

TABLE 4

Stepwise Multiple Linear Regression on Current Salary
(N=3,656)

Variable	Simple r	Entering Beta	Final Beta
Background			
Sex	-.191	-.171	-.036
Age	.488	.488	.020*
Married	.109	.042	.030
Education			
Years since PhD	.544	.414	.088
Rank in class	.030	.068	.056
Graduate school selectivity	.131	.042	.051
Field: Biology	-.042	-.052	-.072
Chemistry	.066	-.049	-.043
Physics		a	
Math	-.059	-.038	.004*
Civil engineering			
Electrical engineering	.210	.197	.056
Mechanical engineering	.010	.023	.022
Anthropology	-.176	-.081	-.050
Economics	.031	.095	.083
Political science	-.069	-.040	-.012*
Psychology	-.050	-.053	-.019*
Sociology	-.081	-.039	-.015*
Other	.085	.050	.031
Current Job			
University teaching	-.402	-.269	-.382
Univ. research and development	-.148	-.124	-.168
Univ. administration	.035	-.046	-.059
Univ. other	-.186	-.132	-.191
Government teaching	-.018	-.041	-.043
Government research	.038	-.084	-.178
Government administration		a	
Government other	-.020	-.093	-.139
Other teaching			
Other research	.031	-.047	-.072
Other administration	.360	.232	.133
Other other	.029	-.049	-.054
Full-time	.201	.192	.181
Percentage time			
Years on job	.395	.090	.098
Now doing research	-.219	-.085	-.066
Relatedness job/major	-.137	.023	.022
Overall satisfaction		a	
Salary		a	
Publication index	.408	.154	.178
Not underemployed		a	
Nontraditional job			
Employment History			
Employed between BA/PhD	.104	.031	.031
Number of jobs			
Changed career goals		a	
Was seeking new job			
Years full-time since PhD	.552	.170	.177
Current Non-Job Satisfaction			
Satisfaction with life		a	
Satisfaction with leisure		a	
Mobility			
Would look nationwide			
Climate a limitation			
Limited by spouse	-.161	-.046	-.046
Miles job-hometown			
R^2			.625

Note. Regression includes only those employed full-time or part-time, those who have a sector/pwa designation, and those who have values on all variables considered.

*Variable loses significance by last step, F< 3.5.

[a]Variable not included in regression.

showed that women earn less even after adjusting for the time they are not in the labor force. Therefore, number of years in the labor force does not totally account for women's lower salaries.

Mobility is another aspect of human capital which should affect earning capacity. Only one mobility indicator, whether choice of a job location is limited by spouse, is statistically significant in the final step, implying that women PhDs earn less because they are less mobile because of their husbands' jobs. But the difference between men's and women's salaries remained significant after controlling for immobility due to the limiting influence of the spouse. Discrimination still plays a role.

Other variables related to the human capital model are also significant: married people earn more. Rank in graduate school, a proxy for ability, is positively associated with earnings. The significance of graduate school quality confirms previous findings (Solmon, 1975). Those working full time rather than part time earn more, as do those who have published more (a measure of productivity).

In addition to these factors, one set of dichotomous variables was included to determine whether PhD field is related to earnings; another set was included to see whether employment sector and type of primary work affect earnings. (For the "field dummies," physics was excluded so the coefficients measure the divergence of earnings of PhDs in other fields from those of PhDs in physics. For the sector/work activity dummy test, the indicator of employment in government administration was omitted as the reference group.) Compared with beta coefficients on other variables, the coefficients for field dummies were small. However, the lowest salaries are revealed for biologists, anthropologists, and chemists. Those in economics earn the most, followed by engineers and those in "other" fields--primarily environmental scientists and those with interdisciplinary PhDs. These differences probably reflect field differences in PhD production (biology has been a big producer in recent years) and in ability to utilize PhDs from the field in a variety of jobs (e.g., the demand for economists is quite far reaching).

Generally, differences in earnings by sector and type of work are much greater than by field. Those in the omitted sector/work cell, government administration, are among the most highly paid; only administrators in the industrial sector earn more, and the advantage is large. Faculty whose primary work is teaching rather than research earn by far the lowest salaries; those employed by universities and colleges in any capacity are among the lowest paid. Administrators are the highest paid university employees. Nonadministrators in government are paid less than administrators, and most people in industry earn more than university employees.

After controlling for all other variables, those who feel their training is related to their job earn more than others, although the beta weight on the relatedness variable was relatively small. This finding supports the argument that knowledge gained in graduate school can increase one's productivity and value in the labor force, when controlling for work activity and sector. It suggests that the negative simple correlation between relatedness and salary is a function of the relatively low salaries paid to faculty members in all fields. Science and engineering PhDs, then, do not have to forego high salaries in return for the "relatedness" of faculty jobs. There are other high paying "related" jobs in which academic training is an asset. In effect, faculty members are trading salary for something else, or they do not realize that they can utilize their graduate training in other than academic jobs.

Total Publications

Clearly, publication is a major objective for most PhD recipients. Table 5 presents results of the regression to identify correlates with the publication index described above. Current involvement in research that is expected to lead

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Insert Table 5 here

TABLE 5

Stepwise Multiple Linear Regression on Publication Index
(N=3,656)

Variable	Simple r	Entering Beta	Final Beta
Background			
Sex	-.129	-.114	-.044
Age	.370	.370	.041*
Married	.086	.039	.013*
Education			
Years since PhD	.463	.481	.198
Rank in class	.097	.128	.108
Graduate school selectivity	.154	.061	.046
Field: Biology			
Chemistry			
Physics		a	
Math	-.094	-.069	-.073
Civil Engineering			
Electrical engineering	.043	.045	.020*
Mechanical engineering	.031	.028	.023*
Anthropology			
Economics	-.045	-.027	-.033
Political science			
Psychology	-.135	-.151	-.114
Sociology			
Other	.071	.072	.051
Current Job			
University teaching	-.117	-.043	-.077
Univ. research and development			
Univ. administration	-.084	.048	.028
Univ. other	-.051	-.036	-.045
Government teaching	-.040	-.040	-.050
Government research			
Government administration		a	
Government other	-.081	-.040	-.053
Other teaching			
Other research			
Other administration	.089	.051	.031
Other other	-.079	-.043	-.041
Full-time	.040	.036	.033
Percentage time	-.032	-.042	-.060
Years on job	.233	-.040	-.021*
Now doing research	.198	.262	.269
Relatedness job/major			
Overall satisfaction		a	
Salary		a	
Publication index		a	
Not underemployed		a	
Nontraditional job			
Employment History			
Employed between BA/PhD			
Number of jobs	.222	.066	.065
Changed career goals			
Was seeking new job			
Years full-time since PhD	.461	.259	.241
Current Non-Job Satisfaction			
Satisfaction with life		a	
Satisfaction with leisure		a	
Mobility			
Would look nationwide	.102	.072	.070
Climate a limitation			
Limited by spouse			
Miles job-home town	.059	.034	.034
R^2			.373

Note. Regression includes only those employed full-time or part-time, those who have a sector/pwa designation, and those who have values on all variables considered.

*Variable loses significance by last step, F 3.5.

[a] Variable not included in regression.

Table 6

Primary Work Activity, by Employment Sector

(in percentages)

Work	Total			Hard Sciences			Engineering			Social Sciences		
	Faculty	Government	Other	Faculty	Government	Other	Faculty	Government	Other	Faculty	Government	Other
Primary work activity												
Non research only	71.6	54.8	75.5	59.9	46.5	66.6	81.6	61.3	88.2	82.4	65.8	79.9
Research and non research	15.2	4.0	4.8	22.0	4.0	7.2	11.4	5.2	1.5	7.6	3.3	3.7
Research only	13.2	41.2	19.6	18.1	49.6	26.2	7.0	33.5	10.3	10.0	30.9	16.4
Type of research conducted by those indicating only research as primary work activity												
Applied	16.7	44.5	46.8	5.3	34.0	33.9	46.7	63.4	81.0	33.8	61.0	63.3
Evaluation	4.0	10.0	7.6	3.3	6.7	4.2	0.0	6.9	7.1	7.3	22.7	19.7
Experimental/laboratory	43.4	36.1	40.3	54.4	50.4	58.2	26.7	15.9	7.1	21.9	8.5	5.7
Theoretical/other	35.9	9.5	5.3	37.0	8.9	3.7	26.7	13.8	4.8	37.0	7.8	11.3

to publication is the best single predictor of lifetime publication record. Apparently, some people always do research and others never do. Of course, variables relating to age and experience are also strong predictors. Those who have held the most jobs and are the most mobile publish the most material. These findings probably indicate that publication is necessary to find new jobs and to be part of the national PhD labor market. Certainly publication credentials are more transferabl than teaching or administrative skills.

Differences in the field dummies are probably as much a function of the type of publishing as of the opportunity to publish in each field. Articles are given less weight than books in the publication index but, in some fields, articles may take as long to publish as books. In any case, according to the index, mathematics, economics, and psychology PhDs tend to publish less than physics PhDs. Those in interdisciplinary fields tend to publish more. Administrators in academe and in industry are the only group with higher indices than government administrators. Probably, to qualify for administrative positions, one must have published in the past. This finding is consistent with the recent trend for good scholars to become administrators. In the past, administrators had a reputation for never having conducted research. The meaning of the coefficients on sector/work activity dummies may be obscured because another variable controls for whether or not a respondent is currently doing research.

The publication index used as the dependent variable considers the amount of publishing by the doctorates but not the type or other activities in addition to research. Table 6 shows the extent to which doctorate holders view research

Insert Table 6 here

as their primary work. Of course, for faculty members, the most popular alternative to research is teaching, and, for the others, it is administration. Adding the responses of those doing only research and those doing research and another activity as their primary work indicated the proportion of PhDs conducting research. This analysis revealed that nonacademic settings, particularly government, promote more research than academic settings. This should not be surprising, since a large number of faculty members indicate that their primary work is teaching, not research. The breakdown of research by type is similar for those whose primary work is research only and for those whose primary work is both research and non-research activity.

The types of research conducted in various employment sectors is an important policy issue. If certain settings are conducive only to certain types of research, the nation could find that it has serious inadequacies in particular areas even though much research effort is made overall. It is immediately clear that a larger proportion of applied research compared with other types, is conducted in government and industrial settings. The research type most dominant in academe, compared with other settings is theoretical (this category also included "other"). This finding tends to confirm the popular argument that basic research is university-sponsored. Experimental and laboratory research is conducted in all three employment sectors. Some of this work probably falls into the "basic" research category.

In the hard sciences and engineering, faculty members conduct more research than PhDs employed in industry, but the reverse is true in the social sciences. Yet overall, only 28% of faculty members have any type of research as their primary work. Little applied research is done by hard science faculty members; engineering faculty members usually do applied research, while social scientist faculty members do both applied and theoretical research.

Since theoretical research is clearly centered in the university, one potential danger in encouraging science and engineering PhDs to seek nonacademic jobs is a decline in theoretical research. The "theoretical" category alone understates the amount of "basic" research, since some experimental research is also basic.

The number of individuals in each employment sector who might be conducting theoretical research car be estimated. Multiplying the number of PhDs in each sector who do any research by the proportion of those who do theoretical research indicates that the proportions of PhDs in academe, government, and industry who do theoretical research are 10.2%, 5.1% and 1.3%, respectively. In 1975, the numbers of PhDs in the three sectors were 153,200 faculty, 82,000 government, and 26,755 industry (NSF, 1977). These figures imply that 15,600 science and engineering PhDs in academe are conducting theoretical research, but only 4,185 in government and only 350 in industry. The relatively small number of PhDs outside universities conducting theoretical or other research is staggering!

Overall Job Satisfaction

Most policymakers would agree that when PhDs find satisfying jobs, a major goal of graduate education is accomplished. But what types of jobs are satisfying for PhDs: high-paying positions, those that enable people to do research and publish, jobs that use graduate training, or just any academic jobs? The regression presented below in Table 9 attempted to explain overall job satisfaction by these and other factors. Although the list of variables accounts for over 60 percent of the variation in salary and 40 percent in publication record, a similar list, including factors alleged to be the most important determinants of satisfaction, explains only 30 percent of the individual differences in job satisfaction.

The question immediately arises: What do respondents mean by "overall" job satisfaction? To find the answer, a regression was run to define overall job satisfaction by indications of satisfaction with 19 job traits thought to be components of overall satisfaction. Table 7 shows that the four strongest

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Insert Table 7 here

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correlates with overall job satisfaction were satisfaction with challenge, status, opportunity for creativity, and congenial work relationships. It it striking that such academically related traits as opportunity to use training, autonomy and independence, opportunity for scholarly pursuits, job security (tenure), and pressure to publish either had much lower regression weights or did not enter the equation at all. The four leading factors in overall job satisfaction do not necessarily depend on the university environment or on a traditional job.

Table 8 indicated the proportions in each field and sector/work activity cell

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Insert Table 8 here

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which are "very satisfied" overall with the current job. Among those employed in universities, administrators are usually the most satisfied. The characteristics of administrative jobs in academe lead respondents to contradict the allegation that all PhDs want to do research or teach. Only in chemistry, physics, and mechanical engineering did a greater proportion of those whose primary work is teaching indicate they are very satisfied more often than those whose work is research and development. For science and engineering PhDs, research tends to be more satisfying than teaching. Administration and research are the most satisfying for academic, but these are activities most likely to be available outside academe as well. Administration in the "others" sector tends to be very satisfying to at least as great a

TABLE 7

Correlates of Job Satisfaction

(N = 4,941)

Correlate	R	Entering Beta	Final Beta
Challenge	.65	.65	.19
Status	.57	.33	.11
Opportunity for Creativity	.62	.29	.13
Congenial Work Relations	.53	.20	.12
Internal Politics	.49	.12	.07
Opportunity to Use Training or Schooling	.54	.12	.09
Variety in Activities	.58	.10	.07
Resources to Get Job Done	.45	.07	.05
Opportunities for Better Jobs at This Institution	.51	.07	.05
Salary and Fringe Benefits	.29	.05	.04
Policy-Making Power	.56	.06	.06
Autonomy and Independence	.56	.05	.05
Prestige of Employer	.46	.04	.04
Opportunity for Scholarly Pursuits	.47	.04	.03
Job Security	.27	.03	.03
Visibility for Jobs Elsewhere	.45	-.03	-.03
Working Conditions	.35	-.02	.02

<u>Note</u>. $R^2 = .62$. F ratio at 3.8 (all significant).

TABLE 8

Overall Satisfaction with Job, by Field and Employment Sector

(in percentages)

Field	University: Research and Development	University: Administration	University: Teaching	University: Other	Government: Research and Development	Government: Administration	Government: Teaching	Government: Other	Other: Research and Development	Other: Administration	Other: Teaching	Other: Other	N
Biology	54.8	53.3	34.7	37.7	33.0	40.9	*	30.8	33.3	50.0	*	27.9	1,142
Chemistry	27.3	45.5	38.2	34.3	23.7	36.7	*	21.4	30.9	60.3	*	40.0	1,047
Physics	25.5	64.3	34.9	42.1	20.4	33.7	*	23.6	36.6	41.1	*	65.0	858
Mathematics	33.3	42.9	32.2	39.4	26.5	26.5	*	34.8	36.7	50.0	*	39.1	487
Civil engineering	54.5	*	40.0	53.3	35.0	33.3	*	36.4	33.3	*	*	*	205
Mechanical engineering	16.7	75.0	31.6	21.4	25.0	27.6	*	27.8	52.4	50.0	*	60.0	256
Electrical engineering	*	60.0	24.2	*	24.4	38.7	*	38.9	39.1	49.3	*	55.1	593
Economics	39.1	100.0	33.3	46.7	33.3	45.1	*	35.4	58.3	*	*	70.0	436
Political science	*	41.2	41.6	10.0	38.5	38.9	*	41.4	*	*	*	*	238
Anthropology	30.4	*	24.1	41.7	*	43.8	*	26.3	33.3	*	*	33.3	319
Psychology	33.3	40.0	31.4	39.3	25.6	32.1	7.7	27.1	33.3	53.8	54.5	52.5	1,617
Sociology	50.0	*	28.7	15.4	20.0	33.3	*	27.3	38.5	*	*	46.7	231
Other	46.4	36.4	24.7	47.3	35.7	37.4	*	27.8	38.1	45.5	*	43.2	967

Note. Percentages indicate "very satisfied."

proportion as those in academe. Government work is very satisfying to a relatively small share of PhDs.

The largest beta coefficient in the satisfaction outcome regression (Table 9)

Insert Table 9 here

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is associated with the dummy variable distinguishing between those who feel they are underemployed and those who do not. It is less likely that underemployment causes dissatisfaction than that dissatisfaction and underemployment represent similar perceptions of a job. In other words, perceiving oneself as under-employed may relate to perceiving a lack of challenge, status, and creativity, components that can make a job rewarding. Underemployment can also mean a lack of relevance or compensation.

Both salary and relatedness of job to graduate training are significantly related to job satisfaction. Related jobs that are satisfying for reasons other than high salary might be the reward for the mobile faculty in the HERI sample. Similarly, salary may produce job satisfaction, in the absence of relevance, among some of the nonacademically employed. Either money or relevance or both produces satisfied workers, but the effects of relatedness and money are independent. The amount of publication during the career and whether one is currently conducting research are <u>not</u> significantly related to job satisfaction, either in the regression or by simple correlation. Indeed, those in nontraditional jobs are <u>more</u> satisfied than those in traditional jobs. Although the simple correlation between years on the present job and satisfaction is positive, after controlling for salary, years on the job is negatively related to satisfaction. People become dissatisfied after a long period of employment if high salary is not achieved. Other than salary, many satisfying aspects of a job, such as challenge, dissipate over time. Finally, those from more selective institutions are more satisified,

TABLE 9

Stepwise Multiple Linear Regression on Satisfaction with Current Job (N=3,656)

Variable	Simple r	Entering Beta	Final Beta
Background			
Sex	-.042	-.034	-.004*
Age	.028	-.069	-.001*
Married	.054	.054	-.005*
Education			
Years since PhD	.062	.054	.030*
Rank in class	.040	.045	.006*
Graduate school selectivity	.064	.065	.029
Field: Biology			
Chemistry	-.045	-.048	-.022*
Physics		a	
Math	-.036	-.035	.001*
Civil Engineering			
Electrical engineering	.025	.032	-.002*
Mechanical engineering			
Anthropology			
Economics	.032	.034	.022*
Political science			
Psychology	.001	-.035	-.038
Sociology			
Other			
Current Job			
University teaching			
Univ. research and development			
Univ. administration	.063	.060	.046
Univ. other	.029	.040	.033
Government teaching			
Government research			
Government administration		a	
Government other			
Other teaching			
Other research			
Other administration	.101	.063	.062
Other other	.073	.073	.085
Full-time			
Percentage time			
Years on job	.016	-.053	-.045
Now doing research			
Relatedness job/major	.154	.081	.104
Overall satisfaction		a	
Salary	.163	.109	.074
Publication index			
Not underemployed	.421	.414	.316
Nontraditional job	-.021	.063	.050
Employment History			
Employed between BA/PhD			
Number of jobs			
Changed career goals			
Was seeking new job			
Years full-time since PhD			
Current Non-Job Satisfaction			
Satisfaction with life	.403	.304	.304
Satisfaction with leisure			
Mobility			
Would look nationwide			
Climate a limitation			
Limited by spouse			
Miles job-home town			
R^2			.303

Note. Regression includes only those employed full-time or part-time, those who have a sector/pwa designation, and those who have values on all variables considered.

*Variable loses significance by last step, F 3.5.

[a]Variable not included in regression.

even controlling for salary. Perhaps the credential from a better institution enables PhDs to obtain more desirable jobs.

PhD field is not related to job satisfaction, after considering other factors such as employment sector. Those in administration and in "other" work in academe and industry are usually more satisfied than those in any government job, or than those in teaching or research in academe or industry. Apparently, fields affect job satisfaction only to the extent that they are association with higher paying jobs, jobs related to training, and jobs in academic or industrial administration. There is nothing inherent in particular science and engineering fields which leads PhDs to enjoy their work more than others. Mobility does not affect job satisfaction except perhaps through higher salary or relatedness.

The final variable entering the job satisfaction regression is satisfaction with life in general. One of the most provocative questions here is whether job satisfaction substitutes for or complements satisfaction with other aspects of life. Some may argue that there is no need to worry about job satisfaction because workers will balance dissatisfication with happier nonworking lives. However, this study indicates a strong positive correlation between job satisfaction and satisfaction with life. This, along with other recent findings (Solmon & Ochsner, 1978), leads to the conclusion that job satisfaction is an important determinant of life satisfaction, and job dissatisfaction cannot be balanced by satisfaction with other aspects of life.

Table 10 reveals how overall job satisfaction and satisfaction with selected

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Insert Table 10 here

Table 10

Differences in Satisfaction After Job Changes by Type of Change

(in percentages)

Job Aspects	Faculty to Faculty	Government to Faculty	Other to Faculty	Government to Government	Faculty to Government	Other to Government	Other to Other	Faculty to Other	Government to Other
Total									
Overall	62	57	60	55	60	61	68	66	70
Salary	40	27	19	46	73	53	49	62	46
Creativity	55	67	64	46	40	42	56	53	66
Status	49	41	53	54	48	46	60	51	65
Congenial	57	56	48	48	55	51	61	63	66
Challenge	53	58	53	57	54	50	50	68	68
Hard sciences									
Overall	58	43	72	55	59	68	68	66	64
Salary	39	19	25	46	74	50	46	63	50
Creativity	53	65	67	46	34	44	48	47	57
Status	46	26	60	55	44	49	65	53	57
Congenial	58	48	56	46	50	53	52	66	50
Challenge	47	48	60	57	46	53	65	65	57
Engineering									
Overall	60	82	51	65	46	42	69	77	64
Salary	48	27	12	49	59	48	53	73	36
Creativity	52	82	75	45	54	26	54	58	54
Status	52	44	49	64	52	39	49	49	64
Congenial	49	60	37	45	44	36	59	61	50
Challenge	57	90	59	61	56	27	72	68	64
Social sciences									
Overall	65	57	58	53	65	58	67	63	74
Salary	39	31	20	46	76	58	49	58	48
Creativity	58	64	56	47	44	44	63	55	73
Status	50	47	50	50	52	44	61	51	67
Congenial	58	60	50	54	64	55	69	62	76
Challenge	56	54	43	57	61	53	68	69	73

Note. Includes only those on the job for 3 years or less.
Percent more satisfied with selected aspects of current job compared to previous job.

aspects of jobs change after recent moves either within or across employment sectors. Regardless of field, the greatest improvements in overall satisfaction are revealed by those who move into the "other" sector. Opportunities for creativity are improved by moves into faculty jobs, and better work relationships are found on leaving government jobs, despite perceived loss of status from these moves.

Thus, there are trade-offs among the components of overall job satisfaction, as well as among its correlates, by sector: An increase in one job attribute may make up for a decrease in some other job attribute, when actual changes are made.

Conclusions

In assessing the outcomes of the employment situation for science and engineering PhDs, it appears that salary, publication, and relationship of job to graduate study are important determinants of job satisfaction, although publication affects satisfaction only because it relates to salary.

It is clear from the simple tabulations and from the regressions that academic jobs are not the only desirable jobs for science and engineering PhDs. The reasons for job satisfaction go beyond the traditional ones of salary, relatedness, and opportunity to publish. Jobs with challenge, status, opportunities for creativity, and congenial colleagues are desirable. A decline in academic jobs due to demographic factors rather than the national economic situation does not warrant cutbacks in science and engineering. Such cutbacks would result in a serious decline in theoretical research. Perhaps more important, maintenance of PhD production need not result in less satisfying or less productive jobs.

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