COLLEGE QUALITY AND EMPLOYEE JOB PERFORMANCE: EVIDENCE FROM NAVAL OFFICERS

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This study analyzes the effects of college quality and individual academic background on selected job performance measures for officers working in professional and managerial jobs in the U.S. Navy. The study analyzes performance indicators at selected career points for cohorts in two occupational groups. Among staff personnel, who perform mostly administrative and support functions, the authors find that graduates of private schools, regardless of college quality, received better performance appraisals than did other officers. Among line personnel, who perform jobs on ships and submarines and in aviation, graduates of top-rated schools, both public and private, received better appraisals during the early career period. Within both occupational groups, graduates of top-rated private schools were more likely than other officers to be promoted at the up-or-out point. The results are consistent with prior studies that find an earnings premium attached to attendance at elite private colleges.

A growing body of research has extended the literature on the economic returns to college by analyzing how specific characteristics of a college or university relate to the labor market success of its graduates. One line of research has focused on the differential effect of attending more selective post-secondary institutions. Lacking direct measures of worker productivity, most prior studies have used hourly pay or annual earnings as proxies for productivity. Few prior studies have investigated the direct effect of college background on worker productivity. Moreover, despite recent improvements in economists' understanding of internal labor markets in explaining observed relationships between pay, performance, and promotion within firms, no prior studies have linked employees' college backgrounds with performance within a firm's personnel system.

This study exploits a unique micro-level database for a large hierarchical organization to explore the effect of college quality and student academic achievement on selected job performance measures. In particular, we use data on Navy officers who graduated from nearly 1,000 different colleges. The data set contains relatively detailed information on early career performance, including promotion outcomes and

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The personnel data used for the research are restricted. They can be requested from the Navy Bureau of Personnel and the Navy Personnel Research, Studies, and Technology Center.

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annual appraisals by supervisors, and on numerous pre-employment characteristics such as the selectivity of the college attended, college grades, and major. An advantage of this data set for exploring worker productivity is the Navy's well-defined personnel system and hierarchical structure. The research design controls for important differences in career ladders, job assignment policies, and incentives, differences that cannot be controlled for in studies that rely on national surveys.

Analyzing direct job performance measures rather than earnings allows several issues to be explored. For one thing, studies that link college quality and earnings have produced conflicting conclusions. Further, some studies have questioned whether various forms of human capital, including formal education, enhance worker productivity on the job or simply serve as signals of ability differences to employers. Finally, from a policy standpoint the Navy seeks to optimize recruiting efforts by deciding where to locate ROTC units and which students should receive scholarships. The Navy provides full scholarships to ROTC students, and average tuition at private colleges is about five times that at public institutions. Thus, the cost of meeting a given accession requirement of new officers will be higher the greater the proportion of students attending private colleges.

Prior Studies

Most studies of the payoff to college quality have analyzed earnings of cohorts from the National Longitudinal Surveys (NLS). Loury and Garman (1995) analyzed data on men from the NLS High School Class of 1972 (NLS72) and found that both college selectivity and GPA were positively related to weekly earnings, but that college major generally did not have a statistically significant effect. James et al. (1989) also found positive effects of college quality and grades on annual earnings in the NLS72. Brewer and Ehrenberg (1996) and Brewer et al. (1999) analyzed cohort data from the NLS72 and High School and Beyond, with controls for potential selection bias due to individual choices regarding college quality and post-college labor supply. The authors found that attending a top- or middle-rated private college improved annual earnings and that the return to selective institutions has risen over time. They found only limited evidence that estimates of the returns to college quality are biased by failing to account for self-selection.[1]

In contrast, Dale and Kreuger (1999) found that correcting for selection has a major impact on estimates of college quality. They adjusted for non-random selection of applicants to elite colleges by restricting their analysis to groups of students who were accepted and rejected by a set of colleges that were comparable in terms of average SAT scores. Once this selection was controlled in the "matched applicant" model, the positive return to college quality disappeared. However, when the authors used net tuition cost as an alternative quality indicator, they found a sizable internal rate of return (16–18%) to attending high-tuition schools. Furthermore, they found a sizable payoff to higher-quality schools for students from lower-income families.

David Wise (1975a; 1975b) is the only author to have analyzed the effects of college characteristics and academic achievement on worker productivity within a single firm. He found academic major was related to starting salary, while college quality and GPA were mainly of value in explaining promotion. It is noteworthy that Wise observed promotion outcomes only for workers who stayed with the firm. If the perfor-

[1]Both Loury and Garman (1995) and Brewer et al. (1999) included college dropouts and graduates in their samples. If the decision to drop out is correlated with college quality, however, differences in estimated college effects may simply reflect differences in graduation probabilities at more selective schools. Brewer et al. analyzed only one college characteristic—college selectivity—but James et al. (1989) found the estimated impact of college quality to be biased upward if student achievement and major are omitted from the models.

mance measure—promotion—differs systematically between leavers and stayers, self-selection may bias estimated parameters.[2] In particular, if turnover is correlated with college background, the performance effects of college characteristics will be biased. A second limitation of Wise's studies is that they did not capture the explicit structure of the firm's internal labor market or any informal contracts that may characterize the employment relationship.

As is clear from this brief review, the findings of prior studies are inconsistent. One reason for the variation across studies using earnings data may be uneven correction for selection to college type. In addition, results may vary due to unmeasured firm and individual heterogeneity. Key aspects of firms' hiring, pay, promotion, and other personnel policies typically are not observed in these studies. For example, Wise failed to account for the fact that individual cohort members' decisions to remain with a firm up to a given career point result in non-random selection, and also failed to identify workers who were qualified for promotion, which created measurement error in the promotion variable. In the present study, the use of data pertaining to a single employer minimizes the effects of unmeasured firm heterogeneity. We also account for the possibility of selection by explicitly modeling the stay-leave decision using quasi-cohort data. Finally, the problem of measurement error in the promotion variable is addressed by analyzing promotion outcomes only for individuals who are qualified ("in-zone") for a promotion review.

Navy Personnel System and Data Base

The database used in this study captures nearly the entire population of college graduates who began their careers as officers in professional, technical, and managerial jobs in the U.S. Navy over a ten-year period.[3] The data file includes cohorts entering between 1976 and 1985 and tracks them through their first 10 years or until they left the Navy. The database approximates a longitudinal file in that it builds prior employment histories from retrospective data for all officers reviewed for promotion to grade 3 (at four years of service), as well as those who separated after achieving grade 3. Data are available on 27,604 officers reviewed for promotion to grade 3. The samples used to analyze job performance outcomes during the early career period (grades 1–2) shrink depending on availability of the necessary analysis variables. Both the grade 3 performance model and the promotion model are estimated only for those who stayed in the Navy for 10 years.[4]

In the Navy's internal labor market, all officers possess a college diploma and start at the entry grade (grade 1). New hires are assigned to staff or operational (line) communities. Staff officers have a relatively short formal training period and fill mostly administrative and support jobs. Operational specialists receive more extensive formal training and fill jobs in aviation, on submarines, and on ships. An advantage of these data is that all individuals in the same subspecialty receive the same amount of formal training. Because the military finances the college expenses of most entrants, all new hires are obligated for a fixed period (between 4 and 5 years, de-

[2]Focusing on samples of very junior workers (see Brewer and Ehrenberg 1996) does not mitigate this problem, as even junior employees must survive an initial probationary period. Loh (1994) discussed the role of the probationary period in sorting employees by their quit propensity.

[3]The database used for the analysis is constructed by matching individuals in three administrative files: promotion history files; separation files; and files containing annual supervisor reports. The Navy Bureau of Personnel and the Navy Personnel Research and Development Center provided data.

[4]For line (staff) officers, the initial sample of 20,027 (7,577) drops to 14,862 (6,675) for the grade 1–2 performance model due to missing information, especially on college grades. The grade 3 performance and the promotion models are based on 8,895 (4,797) personnel who stayed from year 4 to year 10.

pending on specialty and commissioning program). (See Rand 1994 for a description of the military personnel system.)

A salient feature of the military personnel system is promotion tournaments (Lazear and Rosen 1981; Rosen 1992). Promotion to grade 2 (at year 2) and grade 3 (at year 4) is nearly automatic. The first major promotion hurdle occurs at 10 years of service, when individuals face an up-or-out promotion review to grade 4. The Navy sets overall promotion targets for each major occupational area. These targets depend on vacancies at the next highest grade, which in turn depend on the separation rate of those already in that grade as well as the survival rate of those at higher grades. Officers reviewed for grade 4 promotion are evaluated on the basis of prior annual performance reviews, previous jobs, completion of professional military education courses, and completion of a graduate degree. Each individual is ranked, and officers are promoted until the target promotion rate is obtained. Officers who fail to win promotion to grade 4 leave without a pension.

Job Performance Model Specification

Following Bartel (1996), we assume that relative performance is a function of the stock of accumulated human capital. In the case of professional and managerial employees, cognitive skills are assumed to depend on college background, including grade point average (GPA), and major field of study. The quality of the college attended may affect human capital acquisition due to superior resource inputs provided by more selective schools, or due to peer group effects.[5] David Wise stressed the influence of affective, as well as cognitive, skills on job performance. Work-related affective attributes, such as perseverance, self-discipline, leadership, initiative, and the ability to cooperate, are especially important in the military's team production environment. The performance models specified below incorporate proxies for affective skills as well as the more conventional cognitive factors.

We analyze three main job performance measures. Two indicators measure relative performance for (a) the first four years of service (grades 1–2) and (b) years 4 through 10 (grade 3). The measures are based on scores received on annual performance appraisals written by the individual's supervisor. Even though the evaluation report contains numerous elements, most scores are highly inflated, and there is little variation across individuals. However, one element for which there is significant variation, and which has been identified in prior research as a valid measure of officer job performance, is whether the individual is "recommended for accelerated promotion." Neumann et al. (1989) demonstrated that this recommendation signals a highly effective performer with a strong potential for senior leadership positions.[6] The performance variable used in the analysis below records the percentage of an individual's annual evaluations during each period that received a "recommendation for accelerated promotion." During the first four years, line officers received this mark on 38% of their evaluations and staff officers on 35% of their appraisals. The analysis assumes that performance ratings reflect the impact of acquired human capital on

[5]Monks and Ehrenberg (1999) explored school attributes that may account for differences in the quantity and quality of human capital of students from more selective schools, including differences in faculty resources (faculty pay, percent faculty with Ph.D., percent faculty full-time), financial resources (student-faculty ratio, expenditures per student), alumni contributions, and endowment per student. Winston (1996) explored peer effects.

[6]An advantage of this variable is that it provides a cumulative record of performance and covers a variety of jobs and supervisors. Only a trivial percentage of officers are actually promoted "early" (ahead of their peers in the cohort). Nonetheless, this recommendation signals that the supervisor views the employee's performance as superior to that of his peers. Interestingly, this element of the appraisal mirrors a question on the rating forms used by other private firms (see Medoff and Abraham 1980).

true productivity. However, it should be noted that human capital effects will be biased downward if, as is likely, the variation in performance ratings is smaller than the variation in true job productivity.

A potential criticism of the above performance indicators is that they are based on subjective evaluations rather than objective output measures. However, in service organizations subjective measures have distinct advantages in analyzing work performance. Furthermore, in organizations that rely heavily on team production, no single objective measure can capture all the dimensions of an individual's work performance. In these settings intangible skills such as interpersonal communication, cooperation, dependability, and team leadership can be assessed only via supervisor appraisals. Baker, Gibbons, and Murphy (1994) found that private firms often use subjective assessments of performance even when objective output measures are readily available.

For officers who remain in the Navy for 10 years, a third performance measure is analyzed—the outcome at the grade 4 promotion review. In addition, a retention model is estimated to provide information on self-selection prior to the grade 4 promotion review. The retention variable captures the likelihood that a new entrant leaves prior to the grade 4 review; 61.7% of staff specialists stay to the up-or-out point, versus only 51.3% of operational specialists. Promotion rates are 73% and 75% for staff and line officers, respectively. We estimate performance models separately for the line and staff occupations due to differences in career paths, evaluation criteria, and promotion opportunities. Career progression differs in terms of the sequence of jobs and types of jobs held, affecting evaluation criteria. Also, the hierarchical structure differs across the two groups.

College Institutional Characteristics

The college variables used in the study are college selectivity, GPA, and academic major. College selectivity is constructed from Barron's *Profiles of American Colleges,* which rates college on a six-point scale based on high school grades and class rank, average SAT scores of entering freshmen, and the percentage of applicants admitted. We first collapse the six Barron's categories into a threefold classification of "top," "middle," and "bottom" quality. "Top-rated" institutions, in our classification scheme, are colleges in Barron's two highest categories ("most competitive" and "highly competitive"); "middle-rated" institutions are those in Barron's two middle categories ("very competitive" and "competitive"); and "bottom-rated" institutions are those in Barron's bottom categories ("less competitive" and "non-competitive"). We then create six college quality/college type categories by interacting the three quality dummies with an indicator variable for public or private control (see Brewer et al. 1999). This permits an analysis of whether performance differences are attributable to college entrance standards or to college type.

Other explanatory variables proxy for different types and amounts of firm-specific human capital. Graduates of the Naval Academy (USNA) matriculate with 30 credits of "professional development," live in a military environment for four years, and receive on-the-job training every summer. Consequently, affective skills of USNA graduates may differ from those of officers who enter the military via other commissioning programs.[7]

Demographic attributes, such as gender and race, are likely to be correlated with the accumulation of specific human capital, in part due to differences in occupational assignment policies. For many years, women were prohibited from serving in operational specialties, which offered the best opportunities for acquiring firm-specific training. Also not represented proportionally across occupations are minori-

[7]The Naval Academy is ranked in Barron's top selectivity category. However, because of the military-specific nature of the education at the Naval Academy, we enter it as a separate dummy variable and exclude it from the college quality indicator.

Table 1. Sample Characteristics by Occupational Specialty.

	Staff		*Line*	
Variable	*Mean*	*S.D.*	*Mean*	*S.D.*
Performance Grade 1–2[a]	.381	.381	.357	.414
Performance Grade 3[b]	.695	.317	.733	.287
Promotion Rate[c]	.730	.443	.749	.433
Top-Rated Private[d]	.094	.292	.121	.326
Medium-Rated Private	.137	.344	.134	.341
Low-Rated Private	.024	.154	.027	.164
Top-Rated Public	.046	.210	.060	.238
Medium-Rated Public	.501	.500	.490	.499
Low-Rated Public	.154	.361	.132	.339
Engineering Major	.201	.401	.314	.464
Science Major	.133	.339	.169	.167
Math Major	.072	.260	.090	.097
Social Science Major	.158	.365	.175	.187
Business Major	.242	.428	.163	.369
Humanities Major	.151	.358	.089	.284
U.S.N.A.	.132	.338	.274	.446
N.R.O.T.C.–Scholarship	.166	.372	.228	.419
N.R.O.T.C.–Non-Scholarship	.029	.169	.031	.175
Officer Candidate School (OCS)	.584	.584	.457	.478
Age at Commissioning	24.12	2.96	23.19	2.42
African-American	.048	.215	.034	.181
Other Minority	.024	.155	.022	.147
Female	.286	.452	.014	.121
Single or Divorced, No Children	.537	.387	.550	.378
Married, No Children	.122	.327	.132	.338
Married, with Children	.322	.467	.309	.462
Unmarried, with Children	.019	.139	.009	.096
GPA	3.111	.934	2.890	.970
N	7,577		9,133	

[a]Line (N=14,863); Staff (N=7,577).
[b]Line (N=8,895); Staff (N=4,797).
[c]Line (N=7,946); Staff (N=4,535).
[d]Computed as percentage of non-USNA officers.

ties, due in part to preferences and in part to academic background. These differences in assignments and the consequences for accumulating firm-specific human capital may affect measured performance and promotion both across and within occupational areas. Marital and family status are captured by four dummy variables: married with no children; married with children; unmarried with children; and single, the omitted category.

Specification of the promotion model differs somewhat from the specifications of the other performance models due to the presence of year effects. Because the Navy promotes officers in order to fill vacancies, promotion opportunities each year depend on cohort size (supply) and vacant positions at the next highest grade (demand). Lacking direct measures of actual vacancies, we include fiscal year dummies in the promotion model to account for differences in each cohort's aggregate promotion opportunity.

Sample characteristics are presented in Table 1. About 14% of Navy personnel attended top-rated colleges, 63% attended middle-rated schools, and 23% attended the lowest-rated schools. By comparison, in the 1972 and 1982 NLS high school cohorts only 6% of civilians who attended college attended top-rated schools, 68%

attended middle-rated schools, and 26% attended bottom-rated colleges (Brewer et al. 1999). The distribution of college majors differs by occupation, with nearly 60% of line officers having a science or engineering major compared to only 40% of staff personnel. The table also highlights the relatively low overall representation of minorities (5–6%), and the concentration of women in staff jobs.[8]

Basic Job Performance Models

Table 2 displays results of estimating the three performance models for line occupations. One noteworthy result is the sizable positive effect of academic achievement, as measured by GPA, on all of the selected performance outcomes. The coefficients on the dummies for college major suggest that technical majors receive performance scores similar to or lower than those of social science majors. Moreover, among those who stay for 10 years there are no differences in promotion by college major, with the exception of business/economics majors. The bottom of Table 2 displays p-values for F-tests (or likelihood ratio tests) of the hypothesis that college majors do not belong in the job performance models. The restrictions are rejected in all models.

With controls for college major and grades, line specialists from the top-rated colleges—both private and public—receive better appraisals during the early career period (grades 1–2) than do line specialists from bottom-rated public institutions, the omitted group. However, the productivity premium for graduating from top private schools is much larger than that for graduating from top public schools; attending an elite private school increases evaluation scores by about 30%, while attending a top-rated public school increases scores by only 10% (at the mean). The effect of graduating from a top- or middle-rated private school is positive in the grade 3 performance scores, for those who remain 10 years. However, the effect of attending top public schools is statistically insignificant in the grade 3 model. Among stayers, the probability of being promoted is about 5 percentage points higher for graduates of top-rated private colleges than for graduates of bottom-rated public schools. Although graduates of bottom-rated private schools are less likely to be promoted than are graduates of bottom-rated public colleges, other differences in college type are statistically insignificant.

African-American line officers receive below-average performance evaluations, but have an average likelihood of being promoted. While women in the line group receive better reports than men in grades 1–2, there is no gender difference in grade 3 appraisals or in rates of promotion to grade 4.

The results for staff specialists in Table 3 reveal that GPA is positively related to job performance and promotion and that technical majors receive significantly lower scores than other majors through the first 10 years (grades 1–3). F-tests for exclusion of majors in columns 1 and 2 reject the null, but the exclusion is accepted in column 3. None of the coefficients on technical majors are statistically significant in the promotion model. Among staff officers, the effect of attending a private school appears to outweigh institutional quality. In grades 1–2, graduates of top- and bottom-rated private schools perform better than public school graduates, whereas in grade 3 all private school graduates outperform bottom-rated public school graduates. The general performance patterns for African-Americans that were observed for line officers are repeated for the staff group. However, no performance advantage is found for women (versus men) in the staff group; in fact, in grade 3 their performance marks are lower than men's. Even so, women are more likely than men to be promoted to grade 4. This may reflect selection among women in this heavily male-dominated organization.

To investigate whether performance differs by race or gender across college type,

[8]The low representation of women in line jobs reflects historical prohibitions on women serving on ships and in aircraft. Women are still prohibited from serving on submarines.

Table 2. Performance Models for Line Specialties.

Variable	Outcome Variables: Performance Evaluation, Grades 1–2	Performance Evaluation, Grade 3	Grade 4 Promotion Probit
Top-Rated Private	.089***	.086***	.161**
	(.015)	(.014)	(.078)
			[.049]
Middle-Rated Private	.020	.039***	.044
	(.014)	(.013)	(.069)
			[.013]
Bottom-Rated Private	−.003	−.022	−.238**
	(.025)	(.022)	(.111)
			[−.073]
Top-Rated Public	.042**	.014	.074
	(.018)	(.016)	(.089)
			[.021]
Middle-Rated Public	.016	.013	.049
	(.011)	(.010)	(.053)
			[.015]
Engineering Major	.015	.003	.043
	(.010)	(.008)	(.047)
Science Major	−.043***	−.043***	.037
	(.011)	(.011)	(.063)
Math Major	−.021	.034***	.148***
	(.013)	(.003)	(.017)
Business Major	.018	.011	.126**
	(.011)	(.009)	(.053)
Humanities Major	−.029**	−.014	−.092
	(.013)	(.012)	(.064)
GPA	.054***	.041***	.155***
	(.003)	(.003)	(.016)
Age	−.003*	−.001	−.065***
	(.001)	(.001)	(.008)
Married	.090***	.032***	.221***
	(.010)	(.009)	(.047)
Married and Children	.108***	.049***	.318***
	(.007)	(.008)	(.041)
Unmarried and Children	.064*	−.002	.064
	(.034)	(.024)	(.121)
African-American	−.065***	−.048***	−.117
	(.018)	(.017)	(.086)
Other Minority	−.030	−.018	−.140
	(.022)	(.021)	(.108)
Female	.058**	.013	.605**
	(.027)	(.026)	(.161)
Intercept	.205	.585	1.643
N	14,862	8,895	7,946
R^2	.040	.038	—
−2 Log L	—	—	8,586.08
Joint Hypothesis Tests			
College Majors	<.0001[a]	<.0001[a]	.0036[b]
College Selectivity*Female	.8046	.6972	.6896
College Selectivity*Af.-Am.	.2638	.9201	.9731
Marital Status*Female	.8012	.5369	.6933
Marital Status*Af.-Am.	.7664	.4083	.4949

Notes: All models include dummies for commissioning source (USNA, ROTC, OCS). The promotion model also includes dummies for fiscal year. Standard errors are in parentheses; marginal effects are in brackets.

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

[a]p-values for F-tests.

[b]p-values for likelihood ratio tests.

we interacted race and gender separately with college quality indicators. To create the interactions, we used a threefold selectivity classification—high, medium, low—due to the small number of women and minorities. P-values for F-tests (or likelihood ratio tests) on the interaction terms are displayed at the bottom of Tables 2 and 3. Among line officers, all interactions are statistically insignificant. We also investigated interactions between race and gender with marital status. The tests for exclusion of these effects also accepted the null hypothesis in all cases for line officers (p-values are listed at the bottom of Table 2). Note, however, that for line officers cell sizes for some of the interactions are quite small.

P-values for F-tests on similar interactions for staff specialists (bottom of Table 3) reveal that African-Americans from the lowest-rated colleges generally receive lower evaluations than African-Americans from middle- and top-rated colleges throughout their first 10 years (in grades 1–2 and grade 3). Married women, and women with children, receive lower performance marks than other women in grades 1–2, but not in grade 3.[9] Otherwise, interactions in Tables

[9]In a retention probit model (not presented), graduates of top-rated private schools generally are

Table 3. Performance Models for Staff Specialties.

	Outcome Variables		
Variable	*Performance Evaluation, Grades 1–2*	*Performance Evaluation, Grade 3*	*Grade 4 Promotion Probit*
Top-Rated Private	.058**	.073***	.282**
	(.020)	(.017)	(.099)
			[.081]
Middle-Rated Private	.011	.025*	−.049
	(.017)	(.014)	(.074)
			[−.014]
Bottom-Rated Private	.071**	.046*	.058
	(.032)	(.026)	(.136)
			[.016]
Top-Rated Public	.013	.013	−.039
	(.025)	(.021)	(.114)
			[−.011]
Middle-Rated Public	.004	.019*	.010
	(.013)	(.010)	(.056)
			[.002]
Engineering Major	−.087***	−.065***	.068
	(.015)	(.012)	(.072)
Science Major	−.073***	−.053***	−.005
	(.016)	(.013)	(.072)
Math Major	−.066***	−.034**	.042
	(.020)	(.017)	(.092)
Business Major	−.014	.043***	−.009
	(.013)	(.011)	(.062)
Humanities Major	−.065***	−.019	−.114
	(.015)	(.012)	(.078)
GPA	.035***	.020***	.101***
	(.005)	(.004)	(.022)
Age	.009**	.002*	−.026***
	(.001)	(.001)	(.007)
Married	.075***	.035***	.197***
	(.014)	(.012)	(.065)
Married and Children	.086***	.021**	.125**
	(.011)	(.010)	(.055)
Unmarried and Children	.072***	.023	.057
	(.032)	(.023)	(.120)
African-American	−.089***	−.060***	−.261***
	(.021)	(.017)	(.092)
Other Minority	−.066**	−.025	−.065
	(.029)	(.024)	(.129)
Female	.016	−.018*	.179***
	(.011)	(.010)	(.057)
Intercept	.024	.608	.979
N	6,675	4,797	4,535
R^2	.091	.043	—
−2 Log L	—	—	5,134.68
Joint Hypothesis Tests:			
College Majors	<.0001[a]	<.0001[a]	.3925[b]
College Selectivity*Female	.4188	.5638	.7940
College Selectivity*Af.-Am.	.0076[c]	.0001	.2371
Marital Status*Female	.0004[d]	.7367	.3206
Marital Status*Af.-Am.	.3073	.3778	.3451

Notes: All models include dummies for commissioning source (USNA, ROTC, OCS). The promotion model also includes dummies for fiscal year. Standard errors are in parentheses; marginal effects are in brackets.

[a]p-values for F-tests.

[b]p-values for likelihood ratio tests.

[c]Interactions find negative coefficients for African-Americans from the lowest-rated colleges.

[d]Interactions find married women have lower grade 1–2 performance ratings.

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

2 and 3 are statistically insignificant. The tests in the promotion model in column 3 reveal no statistically significant interactions between college selectivity or marital status and race or gender.

Selection-Corrected Job Performance Models

If those who leave the Navy prior to the promotion review are non-randomly selected, key parameter estimates may be biased. A disproportionate number of those who choose to leave before the promotion point may be poor performers whose chances for promotion are below average. Alternatively, leavers may possess above-

more likely to leave the Navy. The retention models used in the two-stage models below (see the appendix) reveal other important differences in retention between line and staff groups. In the line group, technical graduates and those with higher GPA's are more likely to leave. By comparison, among staff personnel there are no retention patterns by major, and those with higher GPA's are less likely to leave. Female line officers are more likely to stay, but female staff personnel are more likely to leave.

Table 4. Effects of College Type in Selection-Adjusted Performance Models.

	Selection-Corrected Grade 3 Performance Model		*Selection-Corrected Promotion Model*	
Variable	*Line*	*Staff*	*Line*	*Staff*
Top-Rated Private	.080***	.082***	.279***	.401***
	(.012)	(.014)	(.065)	(.095)
			[.090]	[.132]
Middle-Rated Private	.024**	.044***	.147**	.072
	(.011)	(.014)	(.058)	(.070)
			[.047]	[.024]
Bottom-Rated Private	−.178	.056*	−.145	.077
	(.224)	(.028)	(.096)	(.132)
			[−.047]	[.025]
Top-Rated Public	.016	.024	.156**	.026
	(.151)	(.022)	(.073)	(.106)
			[.050]	[.008]
Middle-Rated Public	.024***	.051**	.109	.092*
	(.007)	(.010)	(.042)	(.052)
			[.035]	[.030]
GPA	.086***	.103***	.166***	.134***
	(.003)	(.004)	(.015)	(.020)
			[.053]	[.044]
Lambda (λ)	.363***	.315***	—	—
	(.014)	(.021)		
Rho (ρ)			.364***	−.058
	—	—	(.060)	(.109)
N	9,976	4,845	20,027	7,557

Notes: All models include dummies for commissioning program, race, gender, marital status and dependents, and college major. Standard errors are in parentheses; marginal effects are in brackets.

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

average skills and superior civilian job prospects. Although non-random selection could bias estimates in both the grade 3 performance and promotion models, the direction of the correlation between the unobserved components of the retention and promotion outcomes is not clear.

To account for self-selection in the grade 3 performance model, we use a Heckman-style two-step model. For the promotion model an alternative estimator, a bivariate probit, is used, since both outcomes (retention and promotion) are binary. The estimation technique also accounts for the sample truncation that occurs owing to the second outcome (promotion) being observed only for stayers (see Greene 2000). The results of the selection corrections for the basic college quality variables are displayed in Table 4.

The two-step procedure first estimates a reduced form retention choice model, which assumes that individual stay-leave decisions are based on expected returns in civilian and military careers (see Warner and Goldberg 1984). Although expected returns are not measured directly, they are assumed to depend in part on individual characteristics such as sex, age, marital status, race/ethnicity, and civilian employment opportunities. To account for differences in external employment opportunities, we include dummy variables for the main subspecialties—pilot, flight officer, surface officer, and submariner for the line group, and supply corps and restricted line for the staff occupations—in the choice equation, but omit them from the outcome equation. Due to Navy policy, promotion rates should not vary across subspecialties,

but due to differences in external employment opportunities, retention rates should vary across subspecialties. Also, a proxy variable is available that indexes individual retention propensity. Individuals signal long-term career intentions by informing placement officials whether they will attend a Navy-funded graduate education program. Because graduate school attendees incur an additional service obligation, a positive preference for graduate school should be strongly correlated with retention, but not with job performance. Finally, prior enlisted personnel have much higher retention rates than others, because they are committed to 20-year careers; however, we would not expect promotion outcomes to differ for prior enlisted personnel.

The system is identified if at least one variable in the selection equation is omitted from the structural equation. The occupational subspecialty dummies, the graduate school preference variable, and a dummy variable for prior enlisted service are the identifying instruments. A joint test, based on likelihood ratios from alternative model specifications, supports the choice of exclusion restrictions. First-stage retention models appear in the appendix.

The coefficients of the top- and middle-ranked private colleges are reduced slightly in the adjusted grade 3 performance models in Table 4. However, the most notable change is that the coefficient on middle-rated public schools becomes statistically significant in the adjusted estimates. The positive coefficient of lambda in Table 4 suggests that unobserved factors that predict that an individual will stay are correlated with higher performance ratings during the six years in grade 3. These traits, for example, may include a strong work ethic, loyalty to one's employer, willingness to carry out orders unquestioningly, or a deep concern for those in one's charge. What we observe in Table 4 regarding initial job performance is that this self-selection process is not highly related to the earlier choice of college type or quality. That is, we find only minor changes in the estimated coefficients on college type/quality in Table 4 as compared with the relevant coefficients for job performance in grade 3 from Tables 2 and 3. The one exception is for those graduating from middle-rated public colleges, for whom the estimated college quality impact is downwardly biased in the earlier single equation model specifications. Apparently, the unobserved factors (such as those listed above) that are positively related to retention and job performance in grade 3 are more likely to be observed in graduates of non-selective public schools than in graduates of mildly selective colleges. Once these unobserved factors are included in the Heckman-style two-step model of Table 4, we find higher returns to college quality; in general, the estimated effects for middle-rated public schools are twice as large as when we fail to model the self-selection process (.019 versus .051 for staff occupations, and .013 versus .024 for line occupations).

Self-selection on promotion to grade 4 clearly biases downward the single-equation estimates of college type and quality, and in many cases this bias is statistically significant. For example, when selectivity is accounted for, the estimated marginal effect on being promoted to grade 4 increases from +4.9% to +9.0% for graduates of top private colleges, and from +2.1% to +5.0% for top public college graduates. As discussed above, these results could be explained if, for example, graduates of the non-selective public colleges are more likely to possess the unobserved factors correlated with staying, and with winning promotion to grade 4 if they do stay. Failing to take these unobserved factors into consideration when specifying promotion models for experienced workers will bias downward the estimated impact of college type and quality.

The positive error covariance (rho) for line specialists indicates that the simple promotion probit yields biased coefficients. It also suggests that, holding all variables constant, those who quit before the promotion review had a lower predicted promotion probability. In the staff group, the error covariance term is statistically insignificant. Moreover, for staff personnel there

are few differences between the unadjusted and corrected promotion estimates. The main exceptions are that the coefficient on top-rated private colleges increases in size and the coefficient on middle-rated public schools is estimated more precisely.

Note that the potential for bias in estimated coefficients need not be confined to the college quality variables; the coefficients of student achievement and major also could be affected by self-selection of leavers, since college achievement may affect one's civilian employability. In the full model results (available on request), we find few differences in these other coefficients in the two-stage promotion model as compared to the simple probit. Differences between the uncorrected and the two-step grade 3 performance models, however, are more pronounced. The coefficient of GPA in Table 4 increases in size in both occupational groups. Moreover, for staff personnel, coefficients of the college major dummies often change sign in the two-stage models. These results suggest that the impact of self-selection may also be found in personal attributes of college students on top of the impact of college quality/type that is the focus of this study.[10]

Conclusion

By analyzing job performance data for professional and managerial employees in a hierarchical organization, this study extends our understanding of how academic achievement, college major, and college quality are related to worker productivity. We find that, controlling for GPA and major, graduates of elite private colleges demonstrate greater measured on-the-job productivity than do their colleagues.[11] Our results are in line with those of Brewer et al. (1999), who found a large earnings premium to attending elite private institutions and a smaller premium to attending middle-rated private schools. The findings also support prior research that has found a positive relationship between academic achievement and earnings: those with better grades receive higher job performance ratings throughout their careers and are more likely to be promoted. Finally, the study finds little support for the hypothesis that a technical degree is necessary for success in this organization, despite the organization's stress on hiring those with technical majors (see Bowman 1990).

One problem encountered in studies of college quality is bias that arises from unobserved characteristics of students who self-select themselves into certain colleges. The solution in this instance would be to control for pre-college differences in individual backgrounds, such as SAT scores and family attributes. Unfortunately, the administrative files used here do not include such information. However, we controlled for college experience variables, such as GPA and major, which themselves may proxy for unobserved individual characteristics (see James et al. 1989). Thus, we expect background effects will tend to be muted in this study. Still, although we probably reduced selection bias in the estimated college effects, we are unlikely to have eliminated it.[12]

Whether the results in this paper can be generalized to other organizations is an

[10]As a test of robustness of the selection model, we re-specified the first-stage retention model by including the college type interactions. The coefficients of the focus variables in the outcomes equations were largely unaffected by this change, suggesting that the chosen specification is robust. The results also confirm that graduates of top private schools are more likely to leave than are others.

[11]When a simple threefold classification of college quality—high, medium, low—is used, the results reveal strong positive effects of the most selective schools on ratings. However, Tables 2 and 3 show that the college effect is driven largely by the productivity advantage accruing to private schools.

[12]Note, too, that the selection problem is more complex for Navy personnel, as it also involves the decision to accept an ROTC scholarship as well as the choice of college. In addition, officers are assigned to, or select themselves into, occupational groups. Again, the background variables necessary to model these choices are not available in the administrative files.

open question. However, it should be noted that Baker et al. (1994a,b), investigating the hierarchical structure of managerial jobs in a major private firm, found features (with the exception of up-or-out promotion) that are remarkably similar to the Navy's personnel system. For example, in the organization studied by Baker et al., the average tenure in the lowest three grades was between 3 and 4 years, and grade 4 was a crucial point for career advancement. Upper-level jobs in the firm (above grade 4) were characterized as pertaining to general management, managing larger groups, coordinating across units, or strategic planning. The extent of the similarities with the Navy suggests that the results in this paper may generalize to large, hierarchical organizations with highly structured internal labor markets.

From a policy standpoint, the results are mixed. The Navy's goal is to optimize accessions from each of its supply sources, balancing costs and gains to the organization. The Navy appears to reap a positive return during the first 4 years of service on its investments in officers from private colleges. However, graduates of elite private colleges are more likely than other officers to leave the Navy at the end of their initial obligations. Since the initial service obligation of new entrants currently does not vary according to the education costs incurred by the Navy, one policy question is whether the length of the initial service obligation is sufficient to allow recovery of the higher costs associated with entrants from expensive private institutions. Among those who stay beyond the initial obligation, graduates of private colleges receive better performance appraisals and are more likely to be promoted. A calculation based on current Navy accession data and average tuition costs of $15,380 at private schools versus $3,356 at public four-year universities (College Board 1999) suggests that eliminating scholarships at private schools would reduce total direct scholarship costs by nearly 50%. However, such a policy would make recruitment of college students more difficult, and any initial cost savings would likely be offset by the higher recruiting costs. In addition, eliminating students from private schools potentially would reduce the quality of new applicants. Finally, an assessment of the social efficiency of the Navy's scholarship and recruitment policies must recognize that the full social costs of a student from a top public university (that is, including taxpayer subsidies) and one from a private college often do not differ appreciably.

Appendix
Retention Models[a]

Variable	*Line Group Retention Probit*	*Staff Group Retention Probit*	*Variable*	*Line Group Retention Probit*	*Staff Group Retention Probit*
Engineering Major	−.182***	−.006	Unmarried and	.307***	.348***
	(.028)	(.051)	Children	(.007)	(.128)
Science Major	−.112***	−.015	African-American	.016	−.018
	(.031)	(.054)		(.151)	(.072)
Math Major	−.143***	−.125*	Other Minority	−.085	−.178*
	(.037)	(.067)		(.063)	(.098)
Business Major	−.269***	−.080*	Female	.258***	−.208***
	(.031)	(.048)		(.081)	(.042)
Humanities Major	−.177***	−.187***	Prior Enlisted	.656***	.430***
	(.038)	(.053)		(.036)	(.050)
GPA	−.046***	−.001	Pilot/Restricted	.290***	−.296***
	(.009)	(.016)	Line	(.023)	(.046)
Naval Academy	.269***	.073	Flight Officer/Staff	.667***	−.607***
	(.023)	(.048)		(.028)	(.041)
ROTC-Scholarship	.162***	−.150***	Submarine/−	.040	−
	(.024)	(.044)		(.029)	−
ROTC-Contract	.300***	.030	Preference	.354***	.379***
	(.054)	(.089)	Indicator	(.024)	(.032)
Age	−.007***	.022***			
	(.001)	(.002)	Retention Rate	.513	.661
			Intercept	−1.375	1.862
Married	.049***	.137***	N	20,027	7,946
	(.001)	(.039)	−2 Log L	27,140.0	8,579.8
Married and Children	.271	.392***			
	(.029)	(.051)			

[a]Models also include dummies for fiscal year. Dependent variable = 1 for stayers, 0 for non-stayers.
*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

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