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Graduate education and employee performance: evidence from military personnel

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Abstract

Few studies have examined the relationship between on-the-job productivity and graduate education using single-firm data. This paper studies the effect of graduate education on job performance using a unique micro-database consisting of military officers. Supervisor ratings and promotion probabilities are examined for professional and technical officers in the US Navy, a hierarchical organization with an internal labor market and up-or-out promotion policies. Single-stage estimates indicate that, among those eligible to be considered for promotion to grade 4, the up-or-out point, those with any graduate degree are more likely to be promoted. The effect is especially pronounced for those who receive a degree via the Navy's sponsored, full-time program. However, when instruments that are uncorrelated with promotion are used to predict graduate degree status, the results suggest that a sizeable portion of the relationship between graduate education and promotion is due to unobserved attributes that lead some people to attend (or to be selected for) graduate school and to be more promotable. The selection-corrected estimates of the promotion effect of graduate education are reduced by between 40 and 50%. [*JEL* I21, J24] © 1999 Elsevier Science Ltd. All rights reserved.

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1. Introduction

The earnings premium associated with postsecondary degrees (Grogger & Eide, 1995; Cohn & Hughes, 1994) is treated as the private return to education and is often interpreted as a reflection of the differential in productivity for those with more completed education. A considerable literature, however, has questioned whether the wage–schooling relationship is due to learning or to sorting by employers (Weiss, 1995). Aside from the difficulty of determining whether current wages measure productivity, a key issue in the debate is whether the link between education and productivity is causal in nature. Empirical studies using direct measures of productivity have produced inconsistent results. Indeed, the direct link between bachelor's and master's degrees and on-the-job productivity has not been studied extensively. Given the growing emphasis in the work force on formal education, additional research on the direct effect of postsecondary education appears warranted. This study examines the specific relationship between graduate education and on-the-job performance for professional employees in a single large, hierarchical organization.

The study examines the effect of graduate education on job success using a unique micro-database consisting of military officers. The data set contains relatively detailed information on promotion outcomes, performance ratings by supervisors, and numerous background characteristics such as academic achievement and early career performance in the organization. An advantage of the data set in exploring worker productivity is the organization's internal labor market characterized by a vertical hierarchy with a well-defined personnel system. Officer career paths are extremely structured: all officers begin their careers in entry-level positions and possess a

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bachelor's degree; those with master's degrees acquire them after joining the organization; and most advanced education is financed at least in part by the military and is viewed as a form of professional education.

The research should shed some light on the potential benefits of advanced education programs, for nearly all large private firms provide educational benefits to their professional and managerial employees.[1] In addition, the military's personnel system mimics private firms in many ways, so that studying military job performance may provide information on the operation of internal labor markets, including the promotion process and the role of performance evaluations.

The next section of the paper reviews previous studies that have dealt, directly or indirectly, with graduate education and job success. We then describe the personnel data used in the analyses, the Navy's advanced education programs, and the empirical strategy. Following that we present estimates of the performance models. In general, we find that graduate education improves measures of employee job productivity; however, these effects are significantly reduced in instrumental variable estimates that adjust for selection bias.

2. Background

Only a handful of studies have analyzed the relationship between human capital and job performance using firm-level data. Wise (1975a, b) examined the starting salaries, salary growth, and promotion probabilities of managerial and professional employees in a single firm; Gerhart and Milkovich (1989) studied current salaries, salary growth, and the number of promotions over a 6 year period for exempt employees in a manufacturing firm. Wise found that those who acquired graduate degrees after joining the firm earned a 1.2 percentage point premium in annual salary growth, but only if they were ranked in the top third of their class. Promotion probabilities were about 7% higher for those with advanced degrees. Gerhart and Milkovich found that type of degree mattered: an M.A. had a negative effect on salary growth whereas an M.B.A. had a positive effect.

Medoff and Abraham (1980) argued that earnings should be compared only within grade levels due to differences in the type of jobs across grades. After controlling for grade level in their employee data from a manufacturing firm the earnings premium for a master's degree fell from 10 to only 1%. Moreover, while within-grade earnings were higher for advanced degree holders, measured productivity was not. Because only one-tenth to one-fifth of the total return to education was due to higher within-grade earnings, they concluded that master's degree holders earn more simply because at entry they are assigned to jobs in higher grades. Introducing controls for performance evaluations in the earnings models did not move the education coefficients toward zero, implying that differences in performance for those with advanced degrees does not explain the positive within-grade relationship between education and earnings. They concluded that, within groups of comparable jobs, there was no correlation between additional human capital and performance.[2]

Woo (1986) also found that controlling for grade and performance rating reduced the earnings premium for a master's from 7–25 percentage points to only 1 point. Although salary growth rates for master's degrees exceeded those for bachelor's, Woo found an M.B.A had no effect on within-grade performance ratings, and a non-business degree had a negative effect. Further, the probability of promotion was significantly lower for both types of master's degrees. Since performance ratings and promotion are superior to earnings as measures of productivity, she concluded that a graduate degree does not enhance employee productivity.[3]

Several explanations have been offered for the finding that earnings appear to increase with human capital variables, such as advanced degrees, but productivity does not. Weiss and Landau (1985) point out that the distribution of workers on a given job is truncated from above and below; truncation occurs because various criteria must be met initially to be assigned to the job and to keep it, and other criteria must be met (such as higher productivity) to get promoted. Hellerstein and Neumark (1995) note that the productivity indicators in these studies are occupation- and job-level-specific so that productivity and education are examined only for workers who remain in an occupation or a job. Such workers may be unrepresentative in the sense that they do not follow the normal life cycle pattern that involves occupational

[1] A 1986 survey of Fortune 1000 companies revealed that 98% of the 730 respondents had a tuition assistance program. Two-thirds of the companies reimbursed employees for non-job-related courses, especially if they were part of a degree program (O'Neill, 1986). Also, an increasing number of firms are setting up in-house 'corporate colleges'.

[2] This conclusion also applied to other human capital measures, namely pre-company experience and tenure at the firm, which were the primary focus of their papers. These basic results were echoed by Dunson (1985) who used data on federal professional and administrative workers.

[3] Bartel (1995) used a company database to estimate the effects of company-sponsored formal training for professional employees on wage growth and performance ratings. Using an instrumental variables strategy she found that the incidence and duration of formal training increased salary growth rates and performance ratings.

change and promotion.[4] Finally, Medoff and Abraham-type studies examine salary and grade level after entry. If advanced degree holders start at higher grades, subsequent promotion opportunities will tend to be less numerous and to occur at longer time intervals.

These early studies also provide little information on the basic structure of the personnel systems of the firms studied. For example, performance measures are stratified by grade level but it is not known how workers are distributed across current or entry grades by education. Similarly, no information is provided on the firms' education programs, including the timing and source of funding of advanced education, the number of employees who benefitted from these programs and how they were selected, and the specificity of the investments. Finally, the analyses fail to discuss the eligibility of workers to be considered for promotion and promotion rates by grade. Without knowledge of a firm's career ladders, it is difficult to identify the pool of personnel eligible and qualified for promotion within a given grade. Consequently, promotion rates are likely to be mismeasured. In short, these studies do not attempt to integrate the structure of the firm, career paths and career ladders, or the promotion process into the analysis.

3. Data and estimation strategy

The objective of this study is to examine job success for Navy officers. The study concentrates on promotion as the performance measure; however, information on supervisor evaluations is also used. The promotion model focuses on promotion to grade 4, which is the first significant control point in an officer's career and involves an up-or-out decision. All officers enter the military at grade 1 (ensign), and promotions to grade 2 (lieutenant j.g.) and grade 3 (lieutenant) are virtually automatic. Promotion to grade 3 occurs at 4 years of service; up-or-out review is at 10 years.[5] Most officers attend graduate school prior to grade 4, and the majority utilize the Navy's funded program.

The basic information is drawn from the Navy's Promotion History File, which provides background information on all officers reviewed for promotion between 1985 and 1990.[6] This file is augmented with supervisor evaluations (fitness reports) prior to the grade 4 promotion review. Officers are classified into two occupational categories—line and staff. Line specialists work in the primary operational areas of the Navy: aviation, ship operations, and submarine operations. Staff officers perform primarily administrative functions. Within each specialty the set of jobs performed, the level of difficulty of the jobs, and career paths are similar; also, supervisors' evaluations and promotion are based solely on performance within that specific community.[7] After deleting observations with missing data, the merged data file contains 4230 line and 2353 staff officers who were reviewed for promotion to grade 4 between 1985 and 1990.

The specification of the performance models recognizes the military's internal labor market, which is characterized by a vertical hierarchy, no lateral entry, administrative pay setting, and up-or-out promotion. The organization uses contests (or tournaments) to motivate work effort due to the cost of observing and monitoring individual effort (Lazear & Rosen, 1981). In a contest, the organization ranks workers based on evaluations and rewards them on the basis of relative (rather than absolute) performance. The contest determines who is promoted to the next higher rank (Rosen, 1992). Individual promotion probabilities also depend on the aggregate promotion rate to grade 4. The aggregate rate depends on the number of vacancies in the next higher grade at time t, which depends in turn on the number who survive into grade i at t, as well as on survival rates at all higher grades and years of service (Asch & Warner, 1994). Thus, an individual's promotion probability, π_{it}, in this type of organization depends on the aggregate promotion rate, π^*, the individual's own ability (a_i) and effort (e_i) and the abilities and work effort of all others in grade i at time t, (a_o,e_o); that is, $\pi_{it} = \pi_{it}\ (a_{it},e_{it},a_o,e_o,\pi^*)$.

Two important implications of hierarchical organizational forms are that the direct and indirect span of control increases geometrically with rank and that command decisions at higher ranks also have a publicness element.

[4] A sizeable literature has also emerged that attempts to explain the broader puzzle of the positive relationship between experience and earnings versus the negative relationship between experience and productivity. Bishop (1987) discusses numerous reasons why the optimal wage-setting rule for a firm will result in wages that only partially adjust to measured differences in productivity. Hutchens (1989) points out that workers who remain in a given job grade for a long time do so because they have poor evaluations. Lazear (1981) argues that the use of implicit, delayed payment contracts makes it impossible to closely link earnings profiles with the time path of productivity. The various contract and other theories are summarized in Kotlikoff and Gokhale (1992).

[5] For a fuller description of military officer personnel systems, see Rand Corporation (1994).

[6] The data represent 'quasi-cohorts', a set of employees who enter a specific state, such as grade 3, over some period. These groups were reviewed for promotion to grade 4 between 1985 and 1990 and thus represent entry cohorts for 1976–1980. We concentrate on this period because it preceded the personnel turbulence associated with the military downsizing during the 1990s.

[7] Medical and legal specialities are excluded because officers in those fields often enter the Navy with master's degrees.

Individual productivity thus varies positively with rank and assignment policies must allocate the most capable individuals to the higher-ranking positions (Rosen, 1992). Promotion to grade 4 also effectively involves a tenure decision. The use of up-or-out underscores the length of reach of decisions at the next higher level, the potential cost of mis-assigning individuals with poor prospects to the upper ranks, and the importance of a tighter screening of individuals to those ranks (O'Flaherty & Siow, 1995).

4. Estimates of promotion models

The specification of the promotion model assumes that relative performance depends on accumulated human capital (Wise, 1975a, b; Bartel, 1995). Wise partitions human capital into cognitive skills and affective skills. The latter are based on work-related attitudes and attributes such as perseverance, self-discipline, leadership, initiative, and the ability to cooperate, which is especially important in the military's team production environment. In the empirical model below, cognitive abilities are specified as a function of college grade point average, a technical undergraduate degree in science, engineering or mathematics, or a graduate degree. Proxies for affective skills are based on accession source—the Naval Academy, an ROTC scholarship, Officer Candidate School (OCS), or the enlisted ranks. Naval Academy students effectively serve a 4 year apprenticeship before commissioning and thus may assimilate more easily into the military's team production environment.

Other demographic factors, such as gender and race, are likely to be correlated with the accumulation of specific human capital, in part due to differences in occupational assignments. Women for many years were restricted from the line specialties, which offered the best chances for acquiring firm-specific capital. Minorities are also not represented equally in all occupational specialties, due in part to preferences and in part to academic background. These differences in assignments and associated opportunities for accumulating firm-specific human capital may affect promotability both across and within occupational specialty areas. Marital and family status are captured by four categories: married with no children; married with children; divorced with children; and single, the omitted category. Finally, the Navy promotes to fill vacancies so that promotion opportunities vary from year to year depending on cohort size (supply) and vacant slots in the next highest grade (demand). Four fiscal year dummies are included to account for differences in each cohort's aggregate promotion opportunity (π^*).

The first analysis concentrates on job performance during the roughly 9 years prior to the up-or-out review. Information from supervisor evaluations (fitness reports) is used to construct a job performance measure. Even though the evaluation form 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 as a valid measure of job performance is whether the officer is 'recommended for early promotion' (Neumann, Mattson & Abrahams, 1989). We use the percentage of all evaluations during the pre-up-or-out portion of one's career on which the officer received an early-promote recommendation as a measure of job performance.[8]

Table 1 displays descriptive statistics for key variables by officer specialty and degree status. About 18% of the officers reviewed for promotion to grade 4 possess an advanced degree. The unadjusted promotion differential favors those with a degree by 10 percentage points for line officers and by 14 points for staff officers. The proportion of early evaluations carrying the early-promote recommendation is 11–12 percentage points higher for those with M.A. degrees. For most other variables, differences in the means between those with and those without degrees appear slight due in part to the fact that the sample is restricted to officers whose academic background makes them eligible to attend graduate school.

We first estimate the probit promotion model under the assumption that graduate education is exogenous. The probit results for line officers appear in Table 2 and for staff officers in Table 3. Columns 1–4 of Tables 2 and 3 present alternative specifications of the promotion model to evaluate the sensitivity of the effect of graduate education to an increasingly inclusive set of controls. The estimated coefficients of any M.A. degree in Tables 2 and 3 have the expected signs and generally are statistically significant. Among the demographic variables, those who are female, younger, and married, with or without children, are more likely to be promoted. Minorities are less likely to be promoted, but the precision of this estimate falls in the fuller specifications in column 4. The promotion probability for Naval Academy graduates (the omitted category) is significantly higher than for the other accession sources, which supports the notion that Academy graduates enter the Navy with a greater stock of human capital and possibly affective skills.

The results appear to be robust to the different model

[8] The advantage of this variable is that it provides a cumulative record of performance and it covers performance for a variety of jobs and supervisors. Only a trivial proportion of officers are actually ever promoted 'early' (ahead of their peers in the cohort). Nonetheless, this recommendation on the evaluation signals that the supervisor views the employee's performance as superior to his peers. Interestingly, this element mirrors a question on the rating forms used by the private firm in the Medoff and Abraham (1980) study.

Table 1
Descriptive statistics by degree status and occupation[a]

	Line officers		Staff officers	
Variable	Master's	No master's	Master's	No master's
Promotion rate	0.86	0.76	0.84	0.70
Early performance[b] rating (%)	36.22	25.63	36.54	28.77
Technical B.A. (%)	0.65	0.67	0.43	0.57
Grade point average[c]	3.12	2.91	3.24	3.08
ROTC (%)	0.27	0.30	0.34	0.27
OCS (%)	0.25	0.26	0.34	0.42
NESEP (%)	0.07	0.07	0.20	0.13
Naval Academy (%)	0.41	0.37	0.12	0.18
Selective college (%)	0.51	0.55	0.65	0.67
Female (%)	0.02	0.01	0.22	0.18
Age	22.90	22.75	23.52	23.60
Married	0.24	0.25	0.19	0.19
Married with children (%)	0.56	0.51	0.54	0.49
Divorced with children (%)	0.01	0.01	0.01	0.03
Single (%)	0.19	0.23	0.26	0.29
Nonwhite	0.04	0.03	0.06	0.06
N	841	3389	858	1495

[a]Sample based on those reviewed for promotion at grade 4.
[b]Percent of supervisory evaluations that received an 'early promote' recommendation.
[c]Six-point scale: 0 = 0–1.89; 1 = 1.9–2.9; 2 = 2.2–2.59; 3 = 2.6–3.19; 4 = 3.2–3.59; 5 = 3.6–4.0.

specifications. In all specifications, the graduate degree coefficient is positive and significant. The marginal effect of an M.A. is 0.098 and 0.145 for line and staff officers, respectively, which is nearly the same as the unadjusted promotion differences in Table 1. Columns 2–4 reveal that the effect of graduate education is reduced as additional controls, some of which are likely to be correlated with an M.A., are included. The marginal effect falls to 0.057 in column 4 of Table 2 and to 0.089 in column 4 of Table 3, roughly a 40% drop compared to column 1 in both tables. Also, inclusion of the additional controls improves model fit, as the chi-square for the log likelihood ratio rises significantly from column 1 to column 4. A person with a higher GPA has a promotion probability that is about 5 percentage points higher than one with a lower GPA; having a technical undergraduate major makes no difference.

The specification of the single equation model is such that the coefficients of the education variables will be biased if the error term is correlated with the schooling choice. Individuals are assumed to base attendance at graduate school on the expected returns. The sponsored program imposes a cost in the form of an added military service obligation. Hence, those who accept funding view the benefits (in the form of higher promotion probabilities or better assignments) as exceeding the cost of the additional service time; those who reject the program probably do not expect to remain in the Navy owing to superior civilian employment opportunities. The coefficient of the M.A. will represent a bundling of pure education effects and differences in the motivation and career aspirations of individuals choosing to attend graduate school. In addition, it is likely that the organization uses information on job performance to select individuals for the funded program. The measured effect of funded education will be biased upward if the organization assigns more able persons to graduate school.

One technique for addressing the selection issue is to include controls in the models in Tables 2 and 3 for individual ability and the administrative criteria used to choose officers for the funded education program. The two most important selection criteria are academic background and early career performance, attributes which are proxied by college GPA and early performance ratings. College GPA will also index one's cognitive abilities. When these controls are included in Tables 2 and 3, the coefficient of the M.A. drops by about 20% (compare columns 2 and 4 to column 1 in both Table 2 and Table 3).

The above approach attempts to deal with the selection problem by conditioning explicitly on factors likely to be correlated with ability and the likelihood of attending graduate school. Even though these proxies have considerable explanatory power, they may fail to fully capture individual ability and educational preferences. If so, the disturbance term in the model will include the portion of each person's preferences for education not captured by the proxy variables, which may be correlated with

Table 2
Probit promotion models for line officers

	Dependent variable = promotion to grade 4			
Variable	1.	2.	3.	4.
Master's degree	0.376	0.342	0.345	0.265
	(0.059)	(0.060)	(0.060)	(0.065)
	[0.098]	[0.087]	[0.085]	[0.065]
Female	0.710	0.628	0.636	0.502
	(0.244)	(0.246)	(0.246)	(0.249)
Age	− 0.064	− 0.064	− 0.074	− 0.071
	(0.010)	(0.010)	(0.015)	(0.016)
Married	0.191	0.188	0.186	0.137
	(0.064)	(0.064)	(0.064)	(0.069)
Married with children	0.260	0.257	0.255	0.252
	(0.057)	(0.057)	(0.057)	(0.062)
Divorced with children	0.014	0.037	0.035	0.006
	(0.164)	(0.165)	(0.165)	(0.179)
ROTC program	–	–	− 0.275	− 0.266
	–	–	(0.054)	(0.059)
OCS program	–	–	− 0.038	− 0.104
	–	–	(0.069)	(0.074)
NESEP program	–	–	− 0.095	− 0.124
	–	–	(0.119)	(0.130)
College GPA	–	0.183	0.175	0.142
	–	(0.027)	(0.027)	(0.030)
Technical B.A.	–	− 0.032	− 0.030	− 0.010
	–	(0.047)	(0.049)	(0.052)
Minority	− 0.227	− 0.164	− 0.181	− 0.103
	(0.106)	(0.106)	(0.107)	(0.115)
Early performance ratings	–	–	–	0.009
	–	–	–	(0.000)
Constant	1.947	1.439	1.781	1.598
− 2 Log L	4289.0	4242.9	4215.0	3590.2
N	4214	4214	4214	4039

Notes: Standard errors in parentheses; marginal effects in brackets. All specifications include fiscal year dummy variables.

the actual possession of a graduate degree. Our second approach is to address this issue using the following bivariate probit model:

$$Y_i = x_i\beta + I_{G_i}\gamma + \epsilon_{y_i} \quad (1)$$

$$G_i = Z_i\alpha + \epsilon_{G_i} \quad (2)$$

where I_{Gi} is an indicator variable equal to 1 if the individual attends graduate school and equal to 0 otherwise; Y_i is the latent value of being promoted; G_i is the latent value of completing graduate school; x_i is a set of individual characteristics and Z_i includes some of the characteristics in x plus a set of instruments for graduate school completion. We observe that $I_{yi} = 1$ if $y_i > 0$ and $I_{yi} = 0$ if $y_i < 0$; we observe that $I_{Gi} = 1$ if $G_i > 0$ and $I_{Gi} = 0$ if $G_i < 0$. We assume that both ϵ_y and ϵ_G are mean zero, given x and Z and that they are distributed bivariate standard normal.

To obtain the instruments we first estimate a probit model of the determinants of graduate school attendance, which assumes that attendance is based on expected returns and individual characteristics such as sex, age, marital status, and race/ethnicity. The cost of attending graduate school varies across occupational specialties. This is because in some specialties the career path allows little time for leaving the operational environment, so that there is a significant opportunity cost from attending graduate school. In other specialties, the opportunity cost of attending graduate school is high due to strong civilian career opportunities. Thus, the selection model includes dummy variables to control for sub-specialities within the line and staff occupations.

Costs and benefits will also vary across individuals within a subspecialty owing to one's relative position and long-term career interests. A proxy variable is available which indexes the individual's (perceived) position. Officers must keep placement officials informed about career intentions, including whether they will attend

Table 3
Probit promotion models for staff officers

	Dependent variable = promotion to grade 4			
Variable	1.	2.	3.	4.
Master's degree	0.503	0.491	0.497	0.376
	(0.063)	(0.064)	(0.065)	(0.073)
	[0.145]	[0.141]	[0.136]	[0.089]
Female	0.161	0.141	0.181	0.160
	(0.085)	(0.086)	(0.088)	(0.097)
Age	− 0.036	− 0.037	− 0.036	− 0.036
	(0.011)	(0.011)	(0.016)	(0.018)
Married	0.314	0.319	0.308	0.227
	(0.093)	(0.093)	(0.093)	(0.104)
Married with children	0.201	0.205	0.185	0.106
	(0.079)	(0.079)	(0.080)	(0.089)
Divorced with children	0.107	0.112	0.107	0.163
	(0.184)	(0.184)	(0.185)	(0.224)
ROTC	–	–	− 0.271	− 0.155
	–	–	(0.091)	(0.103)
OCS	–	–	− 0.261	− 0.297
	–	–	(0.099)	(0.110)
NESEP	–	–	− 0.113	− 0.093
	–	–	(0.133)	(0.148)
GPA	–	0.079	0.084	0.108
	–	(0.034)	(0.034)	(0.039)
Technical B.A.	–	− 0.010	− 0.057	0.035
	–	(0.061)	(0.066)	(0.073)
Minority	− 0.246	− 0.219	− 0.236	− 0.069
	(0.113)	(0.114)	(0.114)	(0.129)
Early performance rating	–	–	–	0.014
	–	–	–	(0.001)
Constant	1.135	0.913	1.115	0.633
− 2 Log L	2502.3	2495.9	2485.5	1918.9
N	2349	2349	2349	2201

Notes: See Table 2.

graduate school if the program is offered to them. These preferences are recorded in the data file. A positive stated preference for graduate school provides a gauge of the individual's evaluation of the value of graduate education. Moreover, this preference variable should be strongly correlated with attendance at graduate school but not with promotion outcomes. Finally, based on the administrative criteria for selection, the graduate school model includes proxies for the likelihood of being selected for the graduate education program. These include academic preparation (college GPA) and performance in college mathematics and science courses. Since superior performance as a junior officer is also an important selection criterion, the supervisor evaluations variable is included as a proxy for early-career performance. The system is identified if at least one variable in the selection equation is omitted from the structural equation. The occupational dummies, the preference variable, and the college performance variables (other than GPA) serve as the identifying instruments in this case.[9]

The probit selection model results are displayed in the table given in Appendix A. For line officers, the coefficients of college math and science background and early performance ratings are all positive and significant in the model. Early career evaluations have a direct effect on promotion as well as an indirect effect operating through graduate school selection. Individuals from the line specialties hypothesized to have the highest cost of attending graduate school (submarine, aviation, and other line) are less likely to enter the sponsored program. Finally, the preference variable is strongly posi-

[9] A joint test, based on the likelihood ratios from alternative model specifications, supported the choice of exclusion restrictions.

Table 4
Coefficient of any master's degree in single stage and bivariate probit models

	1. No controls for ability/performance	2. Controls for ability/performance	3.a. Bivariate probit	3.b. Error covariance (ρ)
Line officers	0.376	0.265	0.198	0.124
	(0.073)[a]	(0.065)	(0.077)	(0.033)
	[0.098][b]	[0.065]	[0.056]	–
Staff officers	0.503	0.376	0.188	0.170
	(0.063)	(0.073)	(0.108)	(0.039)
	[0.145]	[0.089]	[0.051]	–

[a]Standard errors in parentheses.
[b]Marginal effects in brackets.

tively correlated with the decision to undertake advanced education. For staff officers in column 2 the relationships are similar except that the sub-specialty dummies are insignificant.

Column 3a of Table 4 presents the estimated effect of any M.A. degree in the bivariate probit model. For comparison purposes, the single-stage results with and without controls for ability and early-career performance are reproduced in columns 1 and 2, respectively. The bivariate probit model provides evidence that a large part of the promotion effects in the single-stage models are explained by the selection of more able officers into the graduate education program. The estimated error covariance in column 3b is positive and significant and the coefficient of the M.A. is smaller in the bivariate probit model (compared to single-stage estimates in column 2). The extent of positive selection appears to differ substantially between the two broad occupational fields. For line officers, the coefficient of the M.A. in the bivariate probit model is about 25% smaller than in the single-stage model that included controls for ability and performance (column 2). For staff officers, the effect of an M.A. falls by 50% and the coefficient is significant at only the 0.10 level. In general, the bivariate probit results indicate that the controls for ability and performance in the single equation probit (in column 2) do not fully capture the selection process.[10]

Of the officers with graduate degrees, the majority (75.1% of line officers and 70.8% of staff officers) received them via the Navy's funded program, which pays tuition and salary during attendance at graduate school. Since the funded programs tend to involve more firm-specific training than civilian programs, a question arises as to whether the return to an M.A. reflects a return to general or specific investments. We test this hypothesis by omitting non-funded M.A.s from the sample and comparing individuals with an M.A. from a funded program to individuals without degrees. Table 5 displays the estimated coefficients of the funded M.A. variable. In the single-stage models the return to a funded M.A. for line personnel is nearly double what it is for any M.A. in Table 4, and for staff personnel the return is about 20% higher. However, the bivariate probit results in Table 5 also highlight the greater positive selection for funded degrees than for all degrees in Table 4. Whereas positive selection reduced the return to any M.A. by about one-third for line officers in Table 4, positive selection appears to reduce the return for funded degrees by nearly one-half in Table 5. For staff officers, the return to any M.A. is reduced by two-thirds in the IV estimates in Table 4, but the return to a funded M.A. is reduced by nearly three-quarters in the IV estimates in Table 5. Thus, it appears that both firm specific and general types of investments yield a positive return to employees in this organization.

5. Conclusions

This paper examined the promotion probabilities of professional and technical Navy officers. Single-stage estimates indicate that, among those reviewed for up-or-out promotion to grade 4, promotion probabilities are 10–15 points higher for those with any graduate degree. For those with degrees obtained via the Navy's full-time funded program the differential ranges from 15 to 17 points. However, when instruments that are uncorrelated with promotion are used to predict graduate degree status, the results suggest that a sizeable portion of the relationship between graduate education and promotion is due to unobserved attributes that lead some people to attend (or be selected for) graduate school, especially for the Navy's program, and to be more promotable. The selection-corrected estimates of the promotion effect of graduate education are reduced by between 40 and 50%.

[10] To conserve space only the coefficients of the M.A. variable are presented. Changes in the size of the coefficients of the other control variables in the models are slight between the single stage and bivariate probit estimates.

Table 5
Coefficient of fully-funded master's degree in single stage and bivariate probit models

	1. No controls for ability/performance	2. Controls for ability/performance	3.a. Bivariate probit	3.b. Error covariance (ρ)
Line officers	0.605	0.460	0.170	0.221
	(0.067)[a]	(0.074)	(0.062)	(0.037)
	[0.148][b]	[0.093]	[0.045]	–
Staff officers	0.615	0.440	0.154	0.246
	(0.072)	(0.086)	(0.065)	(0.048)
	[0.172]	[0.101]	[0.046]	–

[a]Standard errors in parentheses.
[b]Marginal effect in brackets.

An important issue is whether the effect of graduate degrees observed here reflects enhancement of the officer's on-the-job productivity or sorting by the firm. At first glance one might reject the sorting argument because the information costs that generate the need for signaling are not as relevant here as they are in the labor market where employers must assess applicants for entry level jobs. Rather, this is a personnel system in which employees have worked for 6 or more years before being selected for graduate education, and 10 years before being reviewed for promotion to grade 4. In the tournament model the firm is assumed to observe productivity and there is no role for signaling. Nonetheless, screening may still be valuable to the organization in this situation because upper levels in the hierarchy require different skills and greater ability than lower levels. Moreover, it is difficult for the organization to observe true ability and this information problem is not entirely solved by observing performance at the lower levels because the difference in the skills required in lower and upper level jobs is so great.

The results in this paper cannot distinguish between these competing explanations of the observed relationship between graduate degrees and promotion. Nonetheless, it appears reasonable to conclude that graduate education in this organization works both directly by augmenting firm-specific skills and by providing a mechanism to sort individuals of greatest value to the organization. Individuals who are more career-oriented and who perform well within this organization signal these attributes via their willingness to attend graduate school and incur the additional costs. Among career-oriented individuals, the Navy selects those whose early performance indicates greater potential for jobs at the upper levels of the organization.

A final issue is whether these results would generalize to the private sector. Recent research suggests that, except for the up-or-out policy, employment systems of private firms share key features with the Navy's hierarchical system. Analyses of the hierarchical structure of managerial jobs in a major private firm have identified the following features identical to the Navy's system: the firm has eight hierarchical levels; the average tenure in the lowest three grades is between 3 and 4 years; grade level 4 is a crucial choke point for career advancement; and upper level jobs in the firm (above grade 4) are characterized as pertaining to general management, managing larger groups, coordinating across units, or strategic planning (Baker, Gibbs & Holmstrom, 1994a; Baker, Gibbs & Holmstrom, 1994b).

Especially important are the similar patterns of outcomes observed in private firms and the Navy. Baker et al. (1994a,b) confirm that private firms promote only those with the best relative performance and Bartel (1995) finds that firms select employees for company-sponsored training on the basis of their early on-the-job performance and that the measured productivity of employees receiving sponsored training exceeds that of managerial employees not receiving the formal training. In addition, the selection corrected effect of a master's degree acquired after joining the organization on the probability of promotion in this study is nearly identical to that obtained by Wise's study of white collar workers in a large corporation. These similarities suggest that the positive relationship between human capital investment and on-the-job performance observed here may generalize to civilian firms.

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Appendix A

Table 6
Bivariate probit estimates of graduate school attendance

Variable	Line officers	Staff officers
Early performance rating	0.0028	0.0033
	(0.0005)	(0.0007)
Preference	0.400	0.153
	(0.046)	(0.053)
Math background	0.402	0.179
	(0.074)	(0.073)
Science background	0.104	0.356
	(0.058)	(0.054)
Submarine specialty	− 0.429	–
	(0.073)	–
Aviation specialty	− 0.271	–
	(0.048)	–
ROTC program	− 0.095	− 0.167
	(0.056)	(0.101)
OCS program	− 0.166	− 0.096
	(0.067)	(0.102)
NESEP program	− 0.263	0.119
	(0.120)	(0.128)
College GPA	0.212	0.129
	(0.025)	(0.031)
Technical B.A.	− 0.008	0.348
	(0.052)	(0.069)
Female	0.131	0.368
	(0.180)	(0.111)
Age	0.023	− 0.011
	(0.012)	(0.012)
Nonwhite	− 0.027	0.089
	(0.107)	(0.111))
Married	0.013	0.049
	(0.065)	(0.085)
Married with children	0.079	0.134
	(0.057)	(0.074)
Divorced with children	− 0.049	− 0.170
	(0.179)	(0.176)
General line community	–	0.136
	–	(0.116)
Restricted line community	–	0.101
	–	(0.070)
Constant	− 2.326	− 1.232

Notes: Standard errors in parentheses.

References

Asch, B. J., & Warner, J. T. (1994). *A theory of compensation and personnel policy*. Santa Monica, CA: Rand Corporation.

Baker, G., Gibbs, M., & Holmstrom, B. (1994a). The internal economics of the firm: evidence from personnel data. *Quarterly Journal of Economics*, *109*(4), 881–920.

Baker, G., Gibbs, M., & Holmstrom, B. (1994b). The wage policy of a firm. *Quarterly Journal of Economics*, *109*(4), 921–956.

Bartel, A. P. (1995). Training, wage growth, and job performance: evidence from a company database. *Journal of Labor Economics*, *13*(3), 401–425.

Bishop, J. (1987). The recognition and reward of employee performance. *Journal of Labor Economics*, *5*(4), S36–S56.

Cohn, E., & Hughes, W. W. (1994). A benefit–cost analysis of investment in college education in the U.S.: 1969–1985. *Economics of Education Review*, *13*(2), 109–123.

Dunson, B. (1985). Pay, experience, and productivity: the government sector case. *Journal of Human Resources*, *20*(1), 153–160.

Gerhart, B. A., & Milkovich, G. T. (1989). Salaries, salary growth, and promotions of men and women in a large, private firm. In R. T. Michael, H. I. Hartmann, & B. O'Farrell, *Pay equity: empirical inquiries.* Washington, DC: National Academy Press.

Grogger, J., & Eide, E. (1995). Changes in college skills and the rise in the college wage premium. *Journal of Human Resources*, *30*(2), 280–310.

Hellerstein, J. K., & Neumark, D. (1995). Are earnings profiles steeper than productivity profiles? *Journal of Human Resources*, *30*(1), 89–112.

Hutchens, R. M. (1989). Seniority, wages, and productivity: a turbulent decade. *Journal of Economic Perspectives*, *3*(4), 49–64.

Kotlikoff, L. J., & Gokhale, J. (1992). Estimating a firm's age–productivity profile using the present value of workers' earning. *Quarterly Journal of Economics*, *107*(4), 1215–1242.

Lazear, E. (1981). Agency, earnings profiles, productivity, and hours restrictions. *American Economic Review*, *71*(4), 606–620.

Lazear, E., & Rosen, S. (1981). Rank-order tournaments as optimum labor contracts. *Journal of Political Economics*, *89*(51), 841–864.

Medoff, J. L., & Abraham, K. G. (1980). Experience, performance, and earnings. *Quarterly Journal of Economy*, *95*, 703–736.

Neumann, I., Mattson, J., & Abrahams, N. (1989). *Development and evaluation of an officer potential composite*. San Diego, CA: Navy Personnel Research and Development Center.

O'Flaherty, B., & Siow, A. (1995). Up-or-out rules in the market for lawyers. *Journal of Labor Economics*, *13*(4), 709–735.

O'Neill, J. P. (1986). *College financial aid and the employee tuition benefits of the Fortune 1000 companies*. Princeton, NJ: Conference University Press,.

Rand Corporation (1994). *Future career management systems for U.S. military officers*. Santa Monica, CA: Rand Corporation.

Rosen, S. (1992). The military as an internal labor market: some allocation, productivity, and incentive problems. *Social Science Quarterly*, *73*(2), 227–237.

Weiss, A. (1995). Human capital vs. signalling explanations of wages. *Journal of Economic Perspectives*, *9*(4), 133–154.

Weiss, A., & Landau, H. (1985). *On the negative correlation between performance and experience and education*. Working Paper 1613. Cambridge, MA: National Bureau of Economic Research.

Wise, D. A. (1975a). Personal attributes, job performance, and probability of promotion. *Econometrica*, *43*(5–6), 913–931.

Wise, D. A. (1975b). Academic achievement and job performance. *American Economic Review*, *65*(3), 350–366.
Woo, J. H. (1986). Graduate degrees and job success: managers in one U.S. corporation. *Economics of Education Review*, *5*(3), 227–237.