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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THE ROLE OF COLLEGE EDUCATION ON THE RETENTION AND PROMOTION OF NAVAL OFFICERS

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NRP FY18 TECHNICAL REPORT

The Role of College Education on the Retention and Promotion of Naval Officers

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ABSTRACT

We analyze whether different aspects of college education (e.g., college major and university ranking) as well as certain demographic features (e.g., gender and marital status) have an effect on retention and performance of U.S. Navy officers at both six and 10 years of service. Regarding retention, separating the sample in URL and RL/STAFF officers, we find that almost none of the individual STEM and non-STEM degrees have a consistent impact on retention. Similarly, regarding officer performance, the effect of having a STEM instead of a non-STEM degree is also unclear.

Keywords: Military, College Education, Retention, Performance, Promotion

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EXECUTIVE SUMMARY

Several academic studies find strong correlations between different aspects of college education and other individual features on job performance and retention in the private sector. This report studies whether those associations are also true for a sample of U.S. Navy officers during the initial years of their military career. Separating the sample in unrestricted line (URL) officers and restricted line or staff (RL/STAFF) officers, we analyze the retention outcomes of Navy officers at six and 10 years of service. In addition, we study officers' job productivity using two alternative measures of job performance: (a) average Fitness Report (FITREP) scores during the first six years of service and (b) the likelihood of promotion to grade O-4.

Our results provide limited empirical evidence on the predictive power of college education and other demographics on officers' performance and retention. For instance, we find that none of the individual college majors used in this study has a systematic impact on retention, both for URL and RL/STAFF officers. The only exception is that an engineering major seems to be negatively associated with retention of RL/STAFF officers at both six and 10 years of service.

When we focus on performance, the relation with the individual college majors (such as Science, Technology, Engineering, and Mathematics (STEM) vs non-STEM) is also unclear. As an example, we find that URL officers with an engineering major have higher chances to be successfully promoted to grade O-4, while we find that RL/STAFF engineers seem to obtain lower relative FITREP averages when compared with social science college majors.

Finally, we find that some individual characteristics are consistently associated with retention and performance. For instance, both URL and RL/STAFF officers who are females or graduates from the United States Naval Academy (USNA) or the Reserve Officer Training Corps (ROTC) are more likely to leave the force at six and 10 years of service. In addition, RL/STAFF officers who belong to racial minorities seem to be more likely to obtain lower relative FITREP averages and are less likely to be promoted to grade O-4.

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I. INTRODUCTION

In recent years, the Navy has adopted several policy initiatives with the purpose of improving and modernizing the management of its workforce. For instance, the Talent Management Initiatives as part of Sailor 2025 aim to improve the match of service members' skills and talents with the necessities of the different warfare communities, to stimulate the culture of fitness, and to prioritize performance-based as opposed to tenure-based promotion (Office of the Secretary of the Navy, 2015).

In part, those initiatives are a consequence of the fact that the Navy continues to introduce new technology to the fleet and, thus, the weapons systems are becoming more sophisticated at an ever-increasing rate. In that context, efforts to recruit officers with technical degrees might seem justified. It has long been assumed that college graduates with degrees in science, technology, engineering, and mathematics (STEM) are attractive to the Navy because they might be more productive on the job, especially as junior officers, and require less training than officers with non-STEM degrees (Bowman, 1990).

However, those potential benefits of technical skills have some associated costs. For instance, it is widely known that some STEM degrees (e.g., engineering) are, on average, quite a bit more expensive than non-STEM degrees (e.g., business; Center for STEM Education and Innovation at American Institutes for Research, 2013). In addition, the private sector offers a considerable wage premium to college graduates with technical degrees. As a result, the recruitment and education of STEM officers might be costlier for the Navy, which, at the same time, might face the risk of lower retention due to the relatively higher-paying jobs in the private sector. It is then helpful for the Navy to be well informed about the potential costs and benefits of those initiatives aimed to attract officers with technical college majors.

The objective of this study is to investigate further the hypothesis that college education background and other individual characteristics have an effect on the performance and retention of Navy officers during the initial years of their military career. To this end, we build on the work of Tick, Nissen, Mehay, and Pema (2017), who analyze whether STEM college degrees, in general, are associated with job productivity and

retention. They report that, while having a STEM college background seems not to affect the retention of URL officers at six and 10 years of service, a STEM major has a positive impact on the promotion of URL officers to grade O-4. Regarding RL/STAFF officers, they find that retention at six years of service and promotion to O-4 are negatively associated with STEM degrees and find no effect on retention at 10 years of service. In other words, they do not find conclusive empirical evidence on the effect of the college STEM background on officer retention and performance.

We complement and extend their work in different ways. First, we study the effect on retention and job performance at a more disaggregated level, separating the STEM/non-STEM college background into several individual college majors that are STEM or non-STEM degrees. Specifically, we disaggregate the STEM college background variable into its four components (i.e., science, technology, engineering, and mathematics) and investigate whether there is a retention or performance effect associated with any of those individual college majors. Second, we add to the analysis the different types of non-STEM degrees, such as social sciences, business, humanities, and biology, to investigate whether they have any impact on the outcome variables of interest. Third, we analyze whether officer retention and performance are related to other individual characteristics, such as gender, marital status, race, and prestige of the school of graduation, among others. Finally, following Moss (2018), we examine an additional measure of performance based on a junior officer's FITREP average trait scores during the first six years of service relative to the cumulative average scores given by her/his reporting senior officer. This job performance measure aims to capture the performance of an individual officer relative to the average performance of all other officers in the same grade assessed by the same reporting senior officer during the initial years of her/his career.

Using data on Navy officers commissioned between 1999 and 2003, followed annually until promotion to O-4 or separation from the Navy, this study investigates retention and job performance measures of junior Navy officers. Specifically, we examine naval junior officers' retention at two different career marks: retention at six years of service, when the minimum service requirement (MSR) has finished, and at 10 years of service, when officers enter the O-4 promotion zone. To analyze job performance outcomes, this study uses two variables: the relative FITREP averages obtained by service

members during the first six years of service, and the probability of promotion to grade O-4 (i.e., around 10 years of service). Finally, we separate our analysis further for URL and RL/STAFF officers.

Overall, consistently at large with the previous literature, we find that our results provide mixed evidence on the effects of college education on naval junior officer retention and performance. Our analyses show that none of the individual STEM and non-STEM college degrees has consistent effects on the retention and job performance measures (with a couple of weak exceptions described in the Empirical Results section). However, a caveat of the current report is that information on the educational background of about 20% of the officer population was missing; therefore, these officers were not included in our study. In addition, critical ability measures, such the college grade point average (GPA) obtained by officers was also missing for most of the individuals in our data set and, thus, we could not use it. The college GPA has long been shown to be a useful predictor of job performance and retention (Bowman & Mehay, 2002) and a critical component of robust statistical analyses that can adjust for potential selection problems that might bias the regression results. The current efforts to attract, train, and retain a talented and diverse force to meet the future manpower needs of the Navy could be supported by more robust analyses based on richer and more complete data sets.

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II. LITERATURE REVIEW

The empirical literature analyzing the different aspects of college education and other individual characteristics as predictors of civilian employees' retention and performance is vast (see Bowman and Mehay, 2002, for a comprehensive review). However, the number of studies examining the same questions for U.S. Navy officers is limited.

Bowman (1990) is one of the first researchers who treid to ascertain whether the choice of college major affects future retention and performance of officers. Using a sample of officers who graduated from the U.S. Naval Academy (USNA) in the period 1976–1980 and chose the surface and submarine warfare communities, he finds that superior performance in the fleet is unrelated to college major or GPA. He also finds that the latter has an insignificant effect on officer retention. However, he reports that retention and performance are significantly associated with other individual factors, such as race and marital status.

O'Connell (1998) investigates whether college quality, college major, and GPA are correlated with job performance for a sample of Navy officers. He measures job performance in two different ways: (a) the percentage of evaluations of an officer that included a "recommendation for early promotion" during grades O-1, O-2, and O-3, and (b) promotion to grade O-4. He finds that college selectivity and GPA are positively correlated with officer performance. However, he reports mixed empirical evidence about college major. For instance, he finds that a technical degree is negatively correlated with obtaining a recommendation for early promotion for RL/STAFF officers from grades O-1 through O-3, while a business/management degree has some positive effect on being promoted to grade O-4.

Bowman and Mehay (2002) study the effects of college selectivity, college major, and GPA on the early career performance of Navy officers, measured by supervisors' annual assessments during the initial years of service and promotion to O-4 at the 10th year of service. The sample includes officers who began their careers in the Navy between 1976 and 1985. They find that for both URL and RL/STAFF officers, GPA is positively

correlated with job performance and promotion. Regarding college major, they find mixed evidence for URL officers, but a strongly negative effect of all STEM degrees on job performance for RL/STAFF officers. In addition, they report that college quality has a significant positive effect on job performance and promotion for both URL and RL/STAFF officers only if the individual graduated from a top-rated private university. Finally, they find that marital status and race have significant effects on career performance.

Parcell, Hodari, and Shufford (2003) employ a sample of URL officers who entered the Navy during the period 1976–1996 to analyze the probability of promotion to O-3, O-4, O-5, and O-6. They find that GPA is positively associated with promotion results. On the contrary, they report that college major and college quality tend to have an insignificant effect on the probability of promotion.

As we described previously, our paper is closest to the study by Tick, Nissen, Mehay, and Pema (2017). It is also close to Maugeri (2016), who, using the same cohorts of Navy officers as Tick et al. but a different methodology to address missing data, analyzes the impact of STEM majors on retention and performance of Navy officers. His results are consistent with those of Tick et al. in the sense that the evidence is inconclusive. Finally, our study uses a measure of performance developed by Moss (2018). While he uses that metric to analyze officer productivity between the sixth and 10th years of service, we use it to evaluate officer performance during the first six years of service.

III. DATA AND DESCRIPTIVE STATISTICS

The data used in this study is drawn from the Defense Manpower Data Center (DMDC), the Bureau of Naval Personnel, and the Navy Personnel Command. It contains individual-level data on the population of Navy officers who commissioned in fiscal year (FY) 1999 to FY2003 and who are then observed annually through their first 10 years of service or until they separate. The initial data set included 23,334 observations. Information on numerous demographics, educational background and service-related characteristics is included for each individual officer commissioned at an O-1 grade, excluding Navy Limited Duty Officers (LDOs) or Warrant Officers. After imposing these restrictions, the resulting data set contains 16,143 observations.

Due to missing information on educational background, such as college major, the resulting data set usable for analysis contains 12,932 observations. The missing educational background information appears to be randomly distributed in the sample across entry cohorts, commissioning sources, and officer communities. FITREP information is available for a random sample of the larger data set, to include data on 7,477 officers.

A. VARIABLE DESCRIPTIONS

1. Dependent Variables: Retention and Performance Measures

Similar to Maugeri (2016) and Tick et al. (2017), this study examines officers' retention at six years of service (YOS), which is the end of the minimum service requirement and the point at which officers can make leave or stay decisions. Retention is also examined at 10 years of service, the point in the officers' career when they can be considered for promotion to O-4 grade. As in Bowman and Mehay (2002) and Moss (2018), performance is measured by two outcomes: the probability of promotion to grade O-4 and a performance measure based on the FITREP scores in the officers' initial years of service. Table 1 shows the definition of each dependent variable used in this study.

Table 1. Dependent Variable Definitions

Dependent Variable Name	Dependent Variable Definition
Six Year Retention	= 1 if officer is in the Navy for at least 6 years; 0, otherwise
Ten Year Retention	= 1 if officer is in the Navy for at least 10 years; 0, otherwise
O-4 Promotion	= 1 if officer is promoted to O-4; 0, otherwise
Top Two Quartile FITREP	= 1 if the 1-6 YOS average of the officer's FITREP average trait scores compared with the reporting senior's cumulative average is in the top two quartiles; 0, otherwise.

2. Independent Variables

The key independent variables in this study capture the officers' educational background by indicating the officers' college majors. Maugeri (2016) and Tick et al. (2017) use two alternative definitions for categorizing the college major into STEM and non-STEM. Given their similar findings when using the alternative STEM definitions, this study uses their broader definition of STEM, based on the degree majors that qualify for NROTC scholarships. The college majors that are categorized as STEM are listed in Table A in the Appendix. This study departs from Maugeri (2016) and Tick et al. (2017) by separating the college major into several categories, similar to Bowman and Mehay (2002). The variable names and variable definitions for the key independent variables are shown in Table 2.

Table 2. Educational Background Independent Variable Definitions

Key Independent Variable Name	Key Independent Variable Definition
STEM Degree	= 1 if officer's college major is a STEM major; 0, otherwise
Non STEM Degree	= 1 if officer's college major is a non-STEM major; 0, otherwise
Engineering	= 1 if officer's college major is an engineering major; 0, otherwise
Mathematics	= 1 if officer's college major is a mathematic or computer science major; 0, otherwise
Physical Sciences	= 1 if officer's college major is a physical science major; 0, otherwise
Social Sciences	= 1 if officer's college major is a social science major; 0, otherwise
Humanities	= 1 if officer's college major is a humanities major; 0, otherwise
Business	= 1 if officer's college major is a business or economics major; 0, otherwise
Biology	= 1 if officer's college major is a biology major; 0, otherwise
Other Major	= 1 if officer's college major is an agriculture, education, medical, law, or communication major; 0, otherwise
High-Quality University	=1 if officer has a college degree from a most competitive university, based on Barron's *Profiles of American Colleges* ranking; 0, otherwise

The other independent variables are organized into categories: demographics, commissioning source, Navy community, and cohort year. All of the multivariate models in this study include cohort dummy variables for the five cohorts who entered between FY1999 and FY2003. The cohort dummies are included to capture unobserved factors that may affect retention and promotion outcomes differently for each cohort. The variable names and variable definitions for all the other independent variables are shown in Table 3.

Table 3. Independent Variable Definitions

Independent Variable Name	Independent Variable Definition
Demographic Characteristics	
Age	Age at commissioning
Female	=1 if Female; 0, otherwise
Male	=1 if Male, 0; 0, otherwise
Dependent Children at 2 YOS	=1 if dependents 2 years after commissioning; 0, otherwise
No Dependent Children at 2 YOS	=1 if no dependents 2 years after commissioning; 0, otherwise
Black	=1 if Black (race) & Non-Hispanic (ethnicity); 0, otherwise
White	=1 if White (race) & Non-Hispanic (ethnicity); 0, otherwise
Asian	=1 if Asian; 0, otherwise
Hispanic	=1 if Hispanic; 0, otherwise
Unknown Race	=1 if Race is not known; 0, otherwise
Married at 2 YOS	=1 if married 2 years after commissioning; 0, otherwise
Not Married at 2 YOS	=1 if not married 2 years after commissioning; 0, otherwise
Commissioning Sources	
Naval Academy	=1 if commissioned from USNA; 0, otherwise
ROTC	=1 if commissioned from ROTC; 0, otherwise
OCS	=1 if commissioned from OCS; 0, otherwise
Direct	=1 if direct commissioning; 0, otherwise
Other Commissioning	=1 if commissioned from other source; 0, otherwise
Navy Community	
Surface Warfare	=1 if Surface Warfare Officer; 0, otherwise
Submarine	=1 if Submarine Officer; 0, otherwise
Aviation	=1 if Naval Pilot; 0, otherwise
Special Operations	=1 if Special Operations Officer; 0, otherwise
General Unrestricted Line	=1 if Unrestricted Line; 0, otherwise
Restricted Line (RL)	=1 if Restricted Line Community; 0, otherwise
Staff	=1 if Staff Community; 0, otherwise
Commissioning Cohorts	
Cohort FY99	=1 if commissioned during fiscal year 1999; 0, otherwise
Cohort FY00	=1 if commissioned during fiscal year 2000; 0, otherwise
Cohort FY01	=1 if commissioned during fiscal year 2001; 0, otherwise
Cohort FY02	=1 if commissioned during fiscal year 2002; 0, otherwise
Cohort FY03	=1 if commissioned during fiscal year 2003; 0, otherwise

B. DESCRIPTIVE STATISTICS

Table 4 shows the descriptive statistics for the variables used in the multivariate retention and promotion models. The first panel shows the outcome variables, while the second panel shows the explanatory variables. Table 4 shows that 53% of new officers entered the Navy with degrees in the STEM classification. Among URL officers, 51% entered with STEM degrees versus 58% of RL/STAFF officers who entered with those degrees.

Table 4. Descriptive Statistics: Larger Data Set (by Community)

Variables	All Communities (n=12,932)	URL (n=10,084)	RL/Staff (n=2,848)
Dependent Variables			
Retention at 6 YOS	0.804	0.742†	0.796
Retention at 10 YOS	0.751	0.747	0.856
Promotion to O4	0.788	0.741	0.849
Independent Variables			
Demographic Characteristics			
Age	24.65	23.88	27.40
Female	0.172	0.139	0.287
Dependent Children at 2 YOS	0.241	0.198	0.390
Married at 2 YOS	0.347	0.312	0.468
White	0.744	0.752	0.715
Black	0.074	0.064	0.107
Asian	0.050	0.041	0.079
Hispanic	0.101	0.111	0.063
Unknown Race	0.031	0.032	0.036
Commissioning Sources			
Naval Academy	0.292	0.357	0.062
ROTC	0.302	0.349	0.132
OCS	0.275	0.226	0.452
Direct	0.059	0.004	0.253
Other Commissioning	0.072	0.064	0.101
Education Background			
STEM Degree	0.528	0.513	0.581
Engineering	0.284	0.256	0.197
Mathematics	0.024	0.0263	0.014
Physical Sciences	0.095	0.109	0.046
Social Sciences	0.214	0.237	0.133
Humanities	0.036	0.0393	0.22
Business	0.141	0.140	0.147
Biology	0.033	0.033	0.037
Other Major	0.136	0.071	0.366
High-Quality University	0.249	0.256	0.224
Navy Community			
SWO	0.241	0.309	-
SUB	0.092	0.118	-
Aviator	0.280	0.359	-
Special Operations	0.019	0.024	-

General Unrestricted Line	0.148	0.190	-
Restricted Line (RL)	0.053	-	0.241
Staff	0.157	-	0.759
Commissioning Cohorts			
Cohort FY99	0.189	0.185	0.204
Cohort FY00	0.215	0.212	0.225
Cohort FY01	0.202	0.198	0.214
Cohort FY02	0.194	0.199	0.177
Cohort FY03	0.200	0.206	0.180

Finally, Table 5 shows the descriptive statistics for the variables used in the modeling of the average FITREP scores. We construct this variable following the procedure described by Moss (2018). The table also shows that the sample is much smaller for officers with available FITREP information.

Table 5. Descriptive Statistics: FITREP Data Set (by Community)

Variables	All Communities (n=7,477)	URL (n=5,226)	RL/Staff (n=2,251)
Dependent Variables			
Top Two Quartile FITREP	0.514	0.478	0.597
Independent Variables			
Demographic Characteristics			
Prior Enlisted	0.219	0.162	0.348
Female	0.172	0.114	0.302
Dependent Children at 2 YOS	0.290	0.237	0.410
Married at 2 YOS	0.399	0.365	0.477
White	0.736	0.745	0.714
Black	0.086	0.073	0.116
Asian	0.054	0.043	0.078
Hispanic	0.092	0.108	0.057
Unknown Race	0.032	0.031	0.035
Commissioning Sources			
Naval Academy	0.238	0.323	0.045
ROTC	0.256	0.303	0.146
OCS	0.326	0.293	0.401
Direct	0.096	0.006	0.302
Other Commissioning	0.084	0.073	0.106
Education Background			
STEM Degree	0.548	0.532	0.586
Engineering	0.273	0.791	0.158
Mathematics	0.024	0.237	0.012
Physical Sciences	0.092	0.323	0.038
Social Sciences	0.187	0.217	0.117
Humanities	0.027	0.030	0.020
Business	0.132	0.126	0.144
Biology	0.030	0.085	0.032
Other Major	0.176		
High-Quality University	0.229	0.237	0.211
Navy Community			
SWO	0.228	0.328	-
SUB	0.101	0.144	-
Aviator	0.226	0.325	-
Special Operations	0.012	0.017	-
General Unrestricted Line	0.128	0.186	-
Restricted Line	0.062	-	0.203

Staff	0.243	-	0.797
Commissioning Cohorts			
Cohort FY99	0.205	0.202	0.211
Cohort FY00	0.214	0.211	0.223
Cohort FY01	0.210	0.205	0.219
Cohort FY02	0.190	0.197	0.175
Cohort FY03	0.181	0.185	0.172

IV. EMPIRICAL RESULTS

In this section, we use multivariate regression analysis to study the effect of college education as well as other individual characteristics on performance and retention of Navy officers. We separate the evaluation of those effects in four different parts: (a) retention at six years of service, (b) retention at 10 years of service, (c) relative FITREP averages, and (d) promotion to O-4. Then, for each of those four parts, we divide the analysis for URL and RL/STAFF officers. Finally, each of the previous subparts is evaluated using two different regression models: (a) a model that includes all STEM degrees in one variable (Model 1) and (b) a model that separates the individual STEM and non-STEM degrees in their component majors (Model 2). The main results of our study are those from Model 2; we include Model 1 to compare our findings with those of Tick et al. (2017).

A. RETENTION AT SIX YEARS OF SERVICE

We start analyzing the results from the regression models at six years of service. Table 6 shows that, for URL officers, none of the individual STEM and non-STEM majors seems to have a significant effect on retention at six years of service. The only exception is the group "other majors," which includes non-STEM degrees such as agriculture, communications, education, law, and medicine, and is negatively correlated with officer retention at the six-year mark. These results should be interpreted relative to the omitted group, which includes the non-STEM major social sciences. In the same line, Model 1 suggests that having a STEM degree in general has no effect on retention at six years of service.

The table also suggests that, relative to OCS, having a degree from the USNA or ROTC has a negative effect on retention at six years of service. As expected, a degree from a highly ranked university decreases the probability of retention at six years of service, as those service members might be subject to greater demand from the private sector. In addition, being female has a negative effect on retention as, in general, women are more likely to attrite from the labor force to bear and raise children. Finally, married and black officers are more likely to remain in the force at the six-year mark.

Table 6. Retention at Six Years of Service: URL Officers

	Model 1	Model 2
Intercept	0.752***	0.754***
	(0.075)	(0.075)
Female	-0.168***	-0.158***
	(0.020)	(0.020)
Dependent Children	0.025	0.023
	(0.015)	(0.015)
Black, Non-Hispanic	0.061***	0.061**
	(0.021)	(0.021)
Asian	-0.013	-0.012
	(0.030)	(0.030)
Hispanic	0.006	0.007
	(0.023)	(0.023)
Married	0.069***	0.067***
	(0.014)	(0.014)
USNA	-0.154***	-0.156***
	(0.020)	(0.020)
ROTC	-0.167***	-0.168***
	(0.017)	(0.017)
Direct Commissioning	0.056	0.050
	(0.039)	(0.039)
STEM Degree	0.013	
	(0.013)	
Engineering		0.029
		(0.017)
Physics		-0.027
		(0.022)
Mathematics		0.035
		(0.036)
Business		0.002
		(0.020)
Humanities		-0.038
		(0.036)
Biology		-0.047
		(0.035)
Other Majors		-0.064*
		(0.026)
High-Quality University	-0.048**	-0.050**
	(0.016)	(0.016)
Cohort FY00	-0.047*	-0.045*
	(0.020)	(0.020)
Cohort FY01	-0.010	-0.009
	(0.019)	(0.019)
Cohort FY02	-0.076***	-0.077***
	(0.020)	(0.020)
Cohort FY03	-0.102***	-0.104***
	(0.020)	(0.020)
Observations	4,577	4,577
R-squared	0.129	0.133

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
The omitted categories are: White, Non-Hispanic; Social sciences; Army; OCS; Cohort FY99.

Table 7 shows the corresponding results for RL/STAFF officers. In this case, having an engineering major has a significant negative effect on retention at six years of service, relative to social sciences in the omitted group. Similarly, a degree in humanities has a barely significant negative coefficient. It is worth noting that Model 1 suggests that officers having a STEM degree in general are less likely to remain in the force at six years of service.

As with URL officers, being female and having a degree from the USNA or ROTC is negatively correlated with retention at the six-year mark. On the contrary, being married or belonging to a minority in terms of race has no effect on retention.

Overall, the previous outcomes provide mixed evidence on the effect of college education on officer retention in the early career years. Moreover, the results from Model 1 are consistent with Tick et al. (2017).

Table 7. Retention at Six Years of Service: RL/STAFF Officers

	Model 1	Model 2
Intercept	0.470***	0.513***
	(0.054)	(0.055)
Female	-0.061***	-0.082***
	(0.018)	(0.018)
Dependent Children	0.030	0.036*
	(0.016)	(0.016)
Black, Non-Hispanic	0.024	0.020
	(0.021)	(0.020)
Asian	0.031	0.028
	(0.024)	(0.024)
Hispanic	0.007	0.014
	(0.031)	(0.031)
Married	0.017	0.014
	(0.016)	(0.016)
USNA	-0.118**	-0.145***
	(0.040)	(0.041)
ROTC	-0.261***	-0.294***
	(0.030)	(0.030)
Direct Commissioning	0.023	-0.006
	(0.016)	(0.018)
STEM Degree	-0.047***	
	(0.014)	
Engineering		-0.111***
		(0.023)
Physics		0.040
		(0.036)
Mathematics		0.028
		(0.056)
Business		0.021
		(0.020)
Humanities		-0.116*
		(0.055)
Biology		0.039
		(0.040)
Other Majors		0.006
		(0.019)
High-Quality University	-0.011	-0.004
	(0.019)	(0.019)
Cohort FY00	-0.016	-0.013
	(0.021)	(0.021)
Cohort FY01	0.048*	0.049*
	(0.020)	(0.020)
Cohort FY02	0.006	0.008
	(0.023)	(0.023)
Cohort FY03	-0.041	-0.042
	(0.025)	(0.024)
Observations	2,841	2,841
R-squared	0.166	0.178

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
The omitted categories are: White, Non-Hispanic; Social sciences; Army; OCS; Cohort FY99.

B. RETENTION AT 10 YEARS OF SERVICE

Table 8 suggests that, for URL officers, only having a degree in business has a barely significant negative coefficient, while the other majors (both STEM and non-STEM) seem to have no impact on retention at 10 years of service. Consistently, Model 1 shows that having a STEM degree in general makes no difference regarding retention at the 10-year mark.

As in the previous subsection, being female and having a degree from the USNA or ROTC is negatively associated with retention at 10 years of service, while married and black officers are more likely to stay in service at the 10-year mark. In addition, having dependent children has a significant positive coefficient. Finally, possibly due to having attractive opportunities in the private sector, officers who graduated from highly ranked universities are more likely to leave the force after 10 years of a military career.

Table 8. Retention at 10 Years of Service: URL Officers

	Model 1	Model 2
Intercept	0.786***	0.796***
	(0.018)	(0.019)
Female	-0.123***	-0.127***
	(0.017)	(0.017)
Dependent Children	0.047***	0.048***
	(0.013)	(0.013)
Black, Non-Hispanic	0.067**	0.071***
	(0.021)	(0.021)
Asian	0.029	0.027
	(0.027)	(0.027)
Hispanic	0.008	0.007
	(0.020)	(0.020)
Married	0.045***	0.045***
	(0.011)	(0.011)
USNA	-0.215***	-0.216***
	(0.016)	(0.016)
ROTC	-0.174***	-0.173***
	(0.013)	(0.013)
Direct Commissioning	-0.010	-0.011
	(0.022)	(0.022)
STEM Degree	0.010	
	(0.011)	
Engineering		-0.000
		(0.014)
Physics		0.021
		(0.019)
Mathematics		-0.024
		(0.032)
Business		-0.047**
		(0.016)
Humanities		0.026
		(0.029)
Biology		0.032
		(0.029)
Other Majors		-0.034
		(0.021)
High-Quality University	-0.049***	-0.048***
	(0.013)	(0.013)
Cohort FY00	-0.033	-0.032
	(0.018)	(0.018)
Cohort FY01	0.023	0.025
	(0.018)	(0.018)
Cohort FY02	0.082***	0.083***
	(0.017)	(0.017)
Cohort FY03	0.102***	0.103***
	(0.018)	(0.018)
Observations	6,577	6,577
R-squared	0.117	0.119

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
The omitted categories are: White, Non-Hispanic; Social sciences; Army; OCS; Cohort FY99.

The regression results regarding RL/STAFF officers are shown in Table 9. In this case, having a degree in engineering has a significant negative coefficient, while having a physics major has a significant positive coefficient, which implies contradicting evidence about the impact of STEM degrees. Model 1 also suggests that a STEM degree in general has no effect on retention at the 10-year mark.

Consistent with the previous results, females and graduates from the USNA or ROTC are less likely to stay in the force after 10 years of service, while having dependent children has the opposite effect. Similarly, graduates from highly ranked universities are more prone to leaving service.

Again, this set of results does not provide clear evidence of the impact of college education on officer retention after 10 years of a military career. The results related to STEM degrees in general are in line with Tick et al. (2017).

Table 9. Retention at 10 Years of Service: RL/STAFF Officers

	Model 1	Model 2
Intercept	0.868***	0.879***
	(0.021)	(0.024)
Female	-0.080***	-0.085***
	(0.017)	(0.018)
Dependent Children	0.044**	0.049**
	(0.016)	(0.016)
Black, Non-Hispanic	0.028	0.026
	(0.023)	(0.023)
Asian	-0.026	-0.028
	(0.026)	(0.026)
Hispanic	0.021	0.022
	(0.030)	(0.030)
Married	0.017	0.013
	(0.015)	(0.015)
USNA	-0.143***	-0.174***
	(0.034)	(0.035)
ROTC	-0.060*	-0.065*
	(0.028)	(0.029)
Direct Commissioning	0.038*	0.031
	(0.017)	(0.019)
STEM Degree	-0.007	
	(0.015)	
Engineering		-0.059**
		(0.022)
Physics		0.092*
		(0.037)
Mathematics		0.037
		(0.060)
Business		-0.010
		(0.023)
Humanities		-0.037
		(0.052)
Biology		0.040
		(0.039)
Other Majors		-0.009
		(0.021)
High-Quality University	-0.041*	-0.040*
	(0.018)	(0.018)
Cohort FY00	-0.037	-0.036
	(0.021)	(0.021)
Cohort FY01	-0.000	0.001
	(0.021)	(0.021)
Cohort FY02	0.017	0.020
	(0.023)	(0.023)
Cohort FY03	0.025	0.024
	(0.024)	(0.024)
Observations	2,280	2,280
R-squared	0.046	0.055

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
The omitted categories are: White, Non-Hispanic; Social sciences; Army; OCS; Cohort FY99.

C. RELATIVE FITREP SCORES

We next analyze whether college education has an impact on the relative performance of an officer as measured by the FITREP metric described in the Data and Descriptive Statistics section. The results for URL officers are shown in Table 10. The relative FITREP average turns out to be uncorrelated with all the individual majors, both STEM and non-STEM. However, Model 1 suggests that a STEM degree in general is associated with lower officer performance according to this measure.

Regarding the other individual characteristics, we find that the relative FITREP average is positively correlated with having dependent children but negatively correlated with being part of a racial minority. In addition, this metric is not related to the quality of the university.

Table 10. Relative FITREP Average: URL Officers

	Model 1	Model 2
Intercept	0.527***	0.515***
	(0.025)	(0.026)
Female	0.034	0.036
	(0.025)	(0.025)
Dependent Children	0.047*	0.046*
	(0.019)	(0.019)
Black, Non-Hispanic	-0.094**	-0.098***
	(0.029)	(0.029)
Asian	-0.064	-0.064
	(0.038)	(0.038)
Hispanic	-0.109***	-0.110***
	(0.030)	(0.030)
Married	0.017	0.019
	(0.017)	(0.017)
USNA	0.007	0.007
	(0.024)	(0.024)
ROTC	0.013	0.011
	(0.020)	(0.020)
Direct Commissioning	-0.040	-0.042
	(0.029)	(0.029)
STEM Degree	-0.037*	
	(0.016)	
Engineering		-0.039
		(0.02)
Physics		0.007
		(0.027)
Mathematics		-0.010
		(0.047)
Business		0.048
		(0.025)
Humanities		-0.032
		(0.048)
Biology		0.008
		(0.045)
Other Majors		-0.014
		(0.032)
High-Quality University	0.007	0.008
	(0.020)	(0.020)
Cohort FY00	-0.031	-0.032
	(0.027)	(0.027)
Cohort FY01	-0.063*	-0.064*
	(0.026)	(0.026)
Cohort FY02	-0.048	-0.048
	(0.026)	(0.026)
Cohort FY03	-0.045	-0.045
	(0.026)	(0.027)
Observations	4,264	4,264
R-squared	0.011	0.012

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
The omitted categories are: White, Non-Hispanic; Social sciences; Army; OCS; Cohort FY99.

Table 11 shows similar results for RL/STAFF officers. That is, only having a degree in engineering is negatively correlated with officer performance as measured by the relative FITREP average. In addition, the coefficient on having a STEM degree in general in Model 1 is strongly significantly negative.

Results related to the other demographics show that being female, being part of a racial minority, or graduating from ROTC has a negative impact on this measure of relative officer performance, while being married or having dependent children has the opposite effect.

Overall, we believe the outcomes described previously do not provide conclusive evidence on whether college education has a clear impact on officer performance during the first six years of service. Finally, the results from Model 1 are consistent at large with the evidence reported by Tick et al. (2017).

Table 11. Relative FITREP Average: RL/STAFF Officers

	Model 1	Model 2
Intercept	0.692***	0.660***
	(0.030)	(0.035)
Female	-0.036	-0.051*
	(0.024)	(0.025)
Dependent Children	0.060**	0.064**
	(0.023)	(0.023)
Black, Non-Hispanic	-0.024	-0.018
	(0.032)	(0.032)
Asian	-0.115**	-0.119**
	(0.038)	(0.038)
Hispanic	-0.052	-0.049
	(0.045)	(0.045)
Married	0.070**	0.068**
	(0.022)	(0.022)
USNA	0.084	0.070
	(0.057)	(0.059)
ROTC	-0.162***	-0.191***
	(0.034)	(0.036)
Direct Commissioning	-0.084***	-0.101***
	(0.024)	(0.027)
STEM Degree	-0.122***	
	-0.022	
Engineering		-0.088*
		-0.034
Physics		-0.042
		-0.058
Mathematics		-0.007
		-0.094
Business		0.048
		-0.035
Humanities		0.032
		-0.075
Biology		0.002
		-0.061
Other Majors		-0.039
		-0.032
High-Quality University	0.023	0.018
	(0.026)	(0.027)
Cohort FY00	-0.035	-0.030
	(0.031)	(0.031)
Cohort FY01	0.026	0.030
	(0.031)	(0.031)
Cohort FY02	-0.019	-0.017
	(0.033)	(0.033)
Cohort FY03	-0.013	-0.014
	(0.033)	(0.033)
Observations	2,251	2,251
R-squared	0.067	0.061

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
The omitted categories are: White, Non-Hispanic; Social sciences; Army; OCS; Cohort FY99.

We end this subsection reporting the results from a robustness check analysis of officer performance. While the previous findings refer to the first six years of service, we now investigate the effects of restricting the analysis to the first four years of service (i.e., while the officers are grades O-1 and O-2). We find that the results remain largely the same as above, both for URL and RL/STAFF officers.

D. PROMOTION TO GRADE O-4

In this final subsection, we describe how the different individual attributes affect the probability of promotion to grade O-4. Starting with URL officers, Table 12 shows that having a degree in engineering or mathematics has a small positive effect on the probability of promotion to O-4, while a degree in humanities has a strong negative coefficient. There are no significant effects from the other STEM and non-STEM majors. In addition, Model 1 suggests that a STEM degree in general is positively correlated with a successful promotion to O-4.

Contrary to the significant results in the previous subsections, being female, having degrees from the USNA or ROTC, having dependent children, or even graduating from a highly ranked university has no impact on the probability of promotion to O-4. However, being married has a strongly positive effect.

Table 12. Promotion to Grade O-4: URL Officers

	Model 1	Model 2
Intercept	0.859***	0.862***
	(0.019)	(0.020)
Female	-0.039	-0.032
	(0.021)	(0.021)
Dependent Children	-0.003	-0.004
	(0.014)	(0.014)
Black, Non-Hispanic	-0.021	-0.024
	(0.022)	(0.023)
Asian	0.014	0.016
	(0.030)	(0.030)
Hispanic	0.002	0.002
	(0.023)	(0.023)
Married	0.070***	0.070***
	(0.013)	(0.013)
USNA	-0.034	-0.033
	(0.018)	(0.018)
ROTC	-0.030*	-0.031*
	(0.015)	(0.015)
Direct Commissioning	-0.018	-0.015
	(0.022)	(0.022)
STEM Degree	0.035**	
	(0.012)	
Engineering		0.041**
		(0.015)
Physics		0.018
		(0.021)
Mathematics		0.097**
		(0.037)
Business		0.006
		(0.018)
Humanities		-0.114***
		(0.033)
Biology		0.023
		(0.033)
Other Majors		0.005
		(0.023)
High-Quality University	0.000	0.001
	(0.015)	(0.015)
Cohort FY00	-0.004	-0.003
	(0.021)	(0.021)
Cohort FY01	-0.017	-0.017
	(0.020)	(0.020)
Cohort FY02	-0.138***	-0.140***
	(0.020)	(0.020)
Cohort FY03	-0.411***	-0.412***
	(0.020)	(0.020)
Observations	4,911	4,911
R-squared	0.151	0.155

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
The omitted categories are: White, Non-Hispanic; Social sciences; Army; OCS; Cohort FY99.

Table 13 shows the regression results for RL/STAFF officers. It is clear that none of the individual majors, STEM or non-STEM, has any impact on the probability of promotion to O-4. In the same line, Model 1 suggests that STEM degrees in general have not effect on promotion to O-4.

Consistent with the results for URL officers, Table 13 also shows that the probability of RL/STAFF officers being promoted to O-4 is uncorrelated with being female, having dependent children, or having a degree from a high-quality university. However, members who belong to a racial minority are less likely to become O-4 officers, while graduates from ROTC have a higher probability of becoming O-4 officers.

In line with the results related to relative FITREP averages, we find weak evidence of the effect of college education on the probability of a successful promotion to O-4. Additionally, the outcomes from Model 1 are similar to Tick et al. (2017).

Table 13. Promotion to Grade O-4: RL/STAFF Officers

	Model 1	Model 2
Intercept	0.886***	0.876***
	(0.024)	(0.027)
Female	0.002	0.001
	(0.020)	(0.021)
Dependent Children	-0.035	-0.035
	(0.018)	(0.018)
Black, Non-Hispanic	-0.057*	-0.056*
	(0.026)	(0.026)
Asian	-0.110***	-0.106***
	(0.030)	(0.030)
Hispanic	-0.089**	-0.089**
	(0.034)	(0.034)
Married	0.018	0.019
	(0.018)	(0.018)
USNA	0.001	0.016
	(0.042)	(0.044)
ROTC	0.112***	0.107**
	(0.034)	(0.034)
Direct Commissioning	-0.012	-0.017
	(0.020)	(0.022)
STEM Degree	-0.007	
	(0.017)	
Engineering		0.001
		(0.026)
Physics		-0.024
		(0.041)
Mathematics		-0.078
		(0.068)
Business		0.020
		(0.026)
Humanities		0.064
		(0.060)
Biology		0.038
		(0.045)
Other Majors		0.010
		(0.024)
High-Quality University	-0.014	-0.017
	(0.021)	(0.022)
Cohort FY00	0.007	0.007
	(0.025)	(0.025)
Cohort FY01	0.010	0.011
	(0.024)	(0.024)
Cohort FY02	0.015	0.015
	(0.026)	(0.026)
Cohort FY03	-0.090***	-0.089***
	(0.027)	(0.027)
Observations	1,976	1,976
R-squared	0.029	0.031

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
The omitted categories are: White, Non-Hispanic; Social sciences; Army; OCS; Cohort FY99.

V. SUMMARY AND CONCLUSIONS

In this report, we analyze whether different aspects of college education (e.g., college major and university ranking) as well as certain personal characteristics (e.g., gender and marital status) have an impact on retention and performance of junior U.S. Navy officers. We study retention at six and 10 years of service, and we analyze two measures of job performance: (a) relative FITREP averages and (b) promotion to grade O-4.

Overall, the empirical evidence shows mixed results that do not support clear conclusions. Separating the sample in URL and RL/STAFF officers, none of the individual STEM and non-STEM degrees has a consistent effect on retention. The only exception worth mentioning is that RL/STAFF officers with an engineering degree seem to be less likely to remain in the force at both six and 10 years of service.

Regarding the two measures of performance, the impact of the individual STEM and non-STEM degrees is also unclear. While URL engineer officers seem more likely to be successfully promoted to O-4, we find that RL/STAFF engineers are more likely to obtain lower relative FITREP averages.

When we focus on the individual characteristics, we find that only a few of them have a consistent effect on retention and performance. For instance, females and graduates from the USNA or ROTC (as opposed to OCS) are less likely to remain in the force at the six- and 10-year marks, both for URL and RL/STAFF officers. Regarding performance, only RL/STAFF officers belonging to racial minorities seem to be less likely to be promoted to grade O-4 and more likely to obtain lower relative FITREP averages.

Finally, the results of this study must be qualified in two ways. First, we had to eliminate about 20% of the officer records from the dataset as they had missing information on the officers' college education backgrounds. Second, the dataset has missing information on the college GPA obtained by most officers in our sample, preventing us from addressing potential selection issues that might bias the coefficients from our regression models. We leave these important issues as recommendations for future research in this relevant manpower topic.

APPENDIX

Table A. STEM Majors. Source: Maugeri (2016).

Aerospace, Aeronautical, Astronautical Engineering	Industrial Engineering	Civil Engineering
Agricultural/Biological Engineering & Bioengineering	Manufacturing Engineering	Computer Engineering
Architectural Engineering/Architectural Engineering Technologies	Materials Engineering	Computer Programming
Astrophysics	Mathematics	Computer Science/Info. Tech.
Biochemistry, Biophysics & Molecular Biology	Mechanical Engineering	Construction Engineering
Biomathematics & Bioinformatics	Metallurgical Engineering	Electrical Engineering
Biomedical/Medical Engineering	Microbiological Sciences and Immunology	Electronics & Comm. Engineering
Biotechnology	Mining & Mineral Engineering	Engineering Mechanics
Cell/Cellular Biology & Anatomical Sciences	Naval Architecture & Marine/Naval Engineering	Engineering Physics
Ceramic Sciences & Engineering	Nuclear & Industrial Radiologic Technology	Engineering Science
Chemical Engineering	Nuclear Engineering	General Engineering
Chemistry	Ocean Engineering	Oceanography
Statistics	Physiology, Pathology & Related Sciences	Petroleum Engineering
Systems Engineering	Polymer/Plastics Engineering	Pharmacology & Toxicology
Textile Sciences & Engineering	Quantitative Economics	Physics

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