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THESIS

AN ANALYSIS OF SURFACE WARFARE OFFICER
MEASURES OF EFFECTIVENESS
AS RELATED TO COMMISSIONING SOURCE,
UNDERGRADUATE EDUCATION, AND NAVY TRAINING

by

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March 1993

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This thesis develops multivariate models to estimate the determinants of three measures of effectiveness for surface warfare officers (SWO): retention, promotion, and early professional qualifications. Using data from the Navy Officer Master File, Navy Officer Loss File, and Navy Personnel Research and Development Center's Traintrack System File, logit regression equations are employed to estimate the probability of SWO retention between the Lieutenant and Lieutenant Commander selection boards (1981-90), the probability of promotion to Lieutenant Commander (1985-90), and the probability of receiving early professional qualifications by the time of the Lieutenant selection boards (1981-85). The probabilities are modeled as a function of background factors that represent personal demographics, undergraduate education, Navy experience, and Navy training. The findings reveal that a large portion of the variation in SWO measures of effectiveness reflect differences in human capital acquired via pre-commissioning education or via Navy training. Performance differences by commissioning source and college selectivity of undergraduate education are specifically highlighted. Based upon the research results, it is recommended that a cost-benefit analysis be conducted to determine the optimal officer accession source mix.

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An Analysis of Surface Warfare Officer Measures of Effectiveness as Related to Commissioning Source, Undergraduate Education, and Navy Training

by

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ABSTRACT

This thesis develops multivariate models to estimate the determinants of the three measures of effectiveness for surface warfare officers (SWO): retention, promotion, and early professional qualifications. Using data from the Navy Officer Master File, Navy Officer Loss File, and Navy Personnel Research and Development Center's Traintrack System File, logit regression equations are employed to estimate the probability of SWO retention between the Lieutenant and Lieutenant Commander selection boards (1981-90), the probability of promotion to Lieutenant Commander (1985-90), and the probability of receiving early professional qualifications by the time of the Lieutenant selection boards (1981-85). The probabilities are modeled as a function of background factors that represent personal demographics, undergraduate education, Navy experience, and Navy training. The findings reveal that a large portion of the variation in SWO measures of effectiveness reflect differences in human capital acquired via pre-commissioning education or via Navy training. Performance differences by commissioning source and college selectivity of undergraduate education are specifically highlighted. Based upon the research results, it is recommended that a cost-benefit analysis be conducted to determine the optimal officer accession source mix.

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I. INTRODUCTION

> *"It is important that the military services critically evaluate the mix of their officer production by source to ensure balance...to meet a substantially reduced demand. I am not an advocate of the lowest-cost and best-return, but costs and return are considerations that can't be ignored."* (Maze 1990)
>
> --Senator John Glenn, Chairman, Subcommittee on Manpower and Personnel, Senate Armed Services Committee

A. BACKGROUND

As the Navy continues to meet reduced officer end strength goals commensurate with the decreasing defense budget, the costs of officer commissioning programs have come under increasing scrutiny. As illustrated by Senator Glenn's comments cited above, the cost differences of the various commissioning sources for all the services have attracted the attention of both the House and Senate Armed Services Committees. There have been at least two General Accounting Office (GAO) studies commissioned to investigate the current methods of operation and cost accounting associated with the two most expensive commissioning programs, which in the Navy are the United States Naval Academy (USNA) and the Navy Reserve Officer Training Corps (NROTC) programs. (U.S. General Accounting Office May, 1991; July, 1991) The other primary commissioning

source is the Officer Candidate School (OCS), which provides college graduates four months of training prior to commissioning. To provide a common point of departure for further analysis and discussion, Table I compares the average cost of the officer commissioning programs as calculated by the GAO (U.S. Congress. Senate., 1991, 229) in column 1, and the Department of the Navy (DoN) (U.S. Congress. Senate., 1991, 286) in column 2. Column 3 compares the marginal cost (as calculated by Strano, 1990) and shows that cost differences narrow considerably when this basis is used.

Table I. AVERAGE AND MARGINAL COSTS OF NAVAL OFFICER COMMISSIONING PROGRAM PER GRADUATE IN 1989 (IN DOLLARS)

ACCESSION SOURCE	GAO REPORT (AVERAGE)	DoN REBUTTAL (AVERAGE)	STRANO (MARGINAL)
USNA	153,000	150,195	56,892
NROTC	53,000	63,606	32,215
OCS	20,000	19,876	7,687

As the Defense Department personnel drawdown continues, both in duration and in scope, the overproduction of officer candidates is increasingly difficult to justify. The GAO reports and accompanying Congressional testimony have highlighted the costs associated with maintaining an officer production line that is not responsive to evolving service requirements. (U.S. General Accounting Office, May 1991; July 1991) The four-year lead times

associated with the services' two high-cost commissioning programs, service academies and reserve officer training corps (ROTC), complicate the analysis for forecasting the future end strength and quality requirements of a smaller officer corps. Although the various cost calculation methodologies differ by service and commissioning program, the focus continues to remain on the difference between program costs as calculated up to the day of commissioning. The differences or "deltas" in program costs have created the impetus to empirically analyze differences in the "returns" based on measurable performance differences that can be weighed against program cost differences.

In response to congressional concerns attempting to reconcile commissioning program cost differences with the subsequent officer performance, the Office of the Assistant Secretary of Defense, Directorate of Accession Policy solicited research in this area. The goal of this study is to define measures of effectiveness (MOE) in officer performance and then relate these MOE to the commissioning source. Presently, the Defense Manpower Data Center (DMDC) is conducting research that will include a special survey of the services to quantify officer MOE and then relate these MOE to the commissioning source. Because there are limitations inherent in drawing policy implications from survey instruments, this thesis develops a methodology utilizing existing databases that will complement DMDC's survey results.

B. OBJECTIVES

In response to OSD's request, this thesis investigates the feasibility of an alternate methodology that would complement current efforts to define and measure officer performance differences. This study examines educational and training (human capital) investments made by both the individual and the organization, and models the individual and cumulative impact of such investments on officer performance. This analysis of officer measures of effectiveness translates those MOE, as defined by this study, into performance differences that can be used to measure the returns on investment from graduates of the different commissioning sources.

Existing databases are investigated by themselves and in combination with other databases that may not have been merged before. From the merged data bases, surface warfare officer MOE are determined and analyzed. Once the MOE are quantified, the effects of the following categories of explanatory variables are analyzed and discussed:

- personal demographics, including commissioning source;
- undergraduate education;
- navy experience; and
- navy training.

This thesis is not intended to be a commissioning source optimization study or a cost-benefit analysis. Rather, this study begins to investigate an improved methodology for determining and measuring officer performance differences.

C. SCOPE, LIMITATION, AND ASSUMPTIONS

The surface warfare officer (SWO) community is the subject of this research effort because critical information pertaining to SWO career paths is more readily available in existing data bases. The structured career path of the SWO consists of a sequential series of qualifications, billets, and administrative screening boards that provide intermediate measures of effectiveness in the interim between statutory promotion boards. Additionally, most of the Navy training a SWO receives is recorded in Navy Personnel Research and Development Center's (NPRDC) Traintrack System files.

Only officers who were graduates of one of the three primary officer commissioning sources; USNA, NROTC, or OCS are included in the sample analyzed. The small percentage of officers who laterally transferred into the surface warfare community from enlisted-to-officer direct commissioning programs were excluded from the data set. The group of officers in the data set constitutes the entire population of officers going before Lieutenant (O-3) (1981-85) and Lieutenant Commander (O-4) (1985-90) promotion selection boards with the exception of those officers who have incomplete data records or who had left the service due to death or disabilities.

This study defines and analyzes retention in a binary fashion, coding for whether or not the individual remained in the service. The reasons for separation and associated indications of a voluntary or involuntary decision to leave the service are not reviewed.

D. ORGANIZATION OF THE STUDY

This study is organized into five chapters. Following the introduction and background contained in Chapter I, Chapter II reviews pertinent studies that relate to the area of research, but do not necessarily address the topic in its entirety. Chapter III describes the contents of the various data files that were combined for this study. A detailed explanation of the research methodologies utilized for the models is also provided. Chapter Iv presents the empirical results of this study. Chapter V summarizes conclusions based upon the statistical analysis. Additionally, overall recommendations derived from this research effort and concluding recommendations for further research are presented.

II. LITERATURE REVIEW

Previous research in the area of officer performance has been extremely limited. The few studies related to this analysis have defined and analyzed measures to quantify officer performance in order to support a particular policy position. Other studies have related officer candidate selection models to subsequent officer performance. Although the objectives of previous research differ from this thesis, the methodologies and associated information provide a logical starting point for the proposed methodology of this study.

A. OFFICER PERFORMANCE

The first study reviewed was Dr. William Bowman's study, "Do Engineers Make Better Naval Officers?", which attempted to test the hypothesis that the best naval officers who graduate from the Naval Academy are those that have a technical undergraduate major. He labels this argument the "Rickover Hypothesis." The objective of Bowman's study was to model the statistical relationship between an individual's academic performance as a USNA midshipman and his later performance as a division officer in the fleet. (Bowman, 1990)

Bowman measured the performance of division officers at the end of their fourth year of service. He also looked at retention by modeling the probability that an officer will remain at least six months beyond the initial length of obligated service.

Bowman studied USNA graduates commissioned from 1976 through 1980 who entered the surface warfare and submarine officer communities. He merged personal demographic and Navy experience data from DMDC's 1986 Navy Officer Master/Loss Files with the associated longitudinal profile of the individual's officer fitness report entries. The officer fitness report files had been developed by NPRDC.

The results showed a very weak statistical relationship between USNA major and fleet performance, as measured by fitness reports and other factors related to ship type and job performance variables. Overall, the analysis did not support the "Rickover Hypothesis" for the group studied. (Bowman, 1990)

In another study dealing with officer performance, "Are Service Academies Worth The Cost?", Bowman looked at the surface warfare and pilot officer communities. He attempted to quantify the "returns on investment" from a particular commissioning source by analyzing retention and promotion. He compiled the "Officer Promotion History Data File," which contained Navy Officer Master/Loss File information at the time of the promotion boards. (Bowman, 1991)

Within the surface warfare community, Bowman found that graduates from "more selective" colleges, based on Barron's Educational Series, 1991 are more likely to leave voluntarily. College selectivity measures are discussed in depth in Chapter III. However, if they make the decision to remain in the service, graduates of more selective schools tend to exhibit higher promotion rates. The pilot community results did not show any relationship between college selectivity and retention. Further analysis of the pilot community found little correlation between college selectivity and officer performance.

Overall, the study supports the view that greater returns on investments in undergraduate education are received from USNA graduates as compared to officers from the other two commissioning sources. In looking at retention to the O-4 selection board career point, Naval Academy graduates are less likely to leave the service as compared to graduates of other accession programs. Finally, Bowman demonstrated that USNA graduates are more likely to be promoted in-zone at the O-4 selection boards as compared to the other commissioning sources. (Bowman, 1991)

Bowman concludes his study by stating that when personal demographic factors were controlled, accession sources are significantly related to measures of officer retention and performance. Finally, Bowman recommends that in the developmental stages of future downsizing policies, the

supporting research include the use of fleet experience data.

Michael Foster in his Master's thesis, "An Analysis Of The Relative Productivity Of Officers From Different Accession Sources," studied the performance of graduates from USNA, ROTC, and OCS. His objective was to compare the relative productivity of officers from different commissioning sources against a performance index based on fitness report data. (Foster, 1990)

Foster examined a sample of 15,365 surface warfare and submarine officers in year groups from 1977 through 1987. NPRDC had complied the fitness report data set which Foster later merged with information from the Navy Officer Master File and the Navy Officer Loss File. Through regression analysis techniques Foster evaluated the effect of the commissioning source on performance through his fitness report based index.

The results of Foster's study showed that USNA graduates outperformed, by a small margin, both ROTC and OCS graduates, when measured against Foster's performance index. Furthermore, he found differences among the year groups which were not explained but could be attributed to data inconsistencies. Lastly, he determined that performance differences existed between personnel that were warfare or engineering qualified and those that were not. Foster concluded his study recommending future research determine the marginal costs associated with the various accession sources.

Marvin Smith of the Congressional Budget Office, in his study "Officer Commissioning Programs," empirically investigates the various officer procurement programs. He attempts to analyze the return on investment from the commissioning programs measured in terms of retention and promotion. He addresses two issues in his paper:

1. Should service academies or a particular accession source be protected against reductions?

2. Should the present balance or proportion of commissioning programs be retained? (Smith, 1991)

Smith focused on the average costs (in 1989 dollars) calculated for the various commissioning programs. Although he stated the need for marginal cost data in evaluating the proper balance of the accession programs, he determined that his data were not sufficient to complete the marginal cost calculations. Based upon his cost analysis, he asked the logical question: are the cost differences between the various commissioning programs reflected in the performance of the graduates? (Smith, 1991)

Smith set out to quantify the performance differences through his analysis of a DMDC file containing officers who entered the services from 1978 through 1988. The total sample size of 255,000 observations included data that captured the commissioning source, personal demographics, education, and military characteristics. He defined his measures of performance as follows:

- length of obligated service, assuming the return on investment would increase with the average months of active duty service; and
- officer productivity as further defined by:

  --time to promotion to O-3 and O-4, and

  --incidence of forced separation from the service.

His overall results do not reflect commissioning source differences of a magnitude great enough to support protecting the size of any single commissioning program as the overall size of the officer corps is reduced. (Smith, 1991) However it appears, Smith's aggregation of the services and the individual officer communities in his analysis and modelling lead to uncompensated biases. His determination of the lack in officer performance differentiation was empirically derived, but his underlying hypothesis, that there should be differences by commissioning source in officer promotion time and in involuntary separations, skewed his analysis and subsequent policy recommendations.

B. OFFICER SELECTIVITY

In her 1989 study, "Development and Evaluation of an Officer Potential Composite," Idell Neumann of NPRDC reviewed the U.S. Naval Academy's midshipman candidate selection system. The objective of the study was to expand the selection system criteria to include predictors of post-commissioning officer performance.

In the course of the analysis Neumann followed a four step process that:

1. developed officer performance standards or measures;

2. evaluated predictive ability of the USNA's current selection system;

3. developed and empirically validated new methodologies that would predict the newly established measures derived from the current selection system; and

4. determined the statistical correlations between officer performance predictors and USNA performance measures. (Neumann, 1989)

The background information available through USNA sources and officer fitness report information available from NPRDC files were combined for officers who graduated from the Naval Academy between 1979 and 1982. The officer fitness report data files contained all of the information resident in a fitness report with the exception of the narrative comments.

Neumann's results showed that there was enough variability in the officer fitness reports to discern differences among the officers studied. Her analysis demonstrated that the measures in the "Recommendation for Early Promotion" block on the fitness report was the critical indicator for differentiating officer performance.

In attempting to relate selection model criteria to the "Recommendation for Early Promotion" statistics, the study found that the variables that described participation in high school activities, both athletic and non-athletic, and recommendations from high school officials commenting on the

individual's future naval officer potential, were statistically significant. Furthermore, the study determined that components of an USNA midshipman's academic performance are statistically related to measures of officer performance as defined by the fitness report data for the "Recommendation for Early Promotion". (Neumann, 1989)

The study concluded by recommending that further research be conducted to empirically determine the relationship between the recommendation for early promotion data and subsequent promotion data. Finally, Neumann identified the need for additional analysis to examine the relationship between retention and the recommendation for early promotion data.

The studies reviewed have demonstrated several methodologies for defining and quantifying officer measures of effectiveness. In each study, the objectives and methodologies utilized were different, which in some cases affected their contribution to the overall discussion. The literature review indicates that, while general definitions of MOE have been analyzed, the differing organizational objectives and associated biases precluded an overall consensus on issues of officer performance.

This study explores improved methodologies for examining officer performance. New measures of quality are defined that provide intermediate MOE for personnel policy analysis. In addition to previously researched MOE, such as retention and promotion, this thesis analyzes an early measure of quality

that has policy implications for future downsizing and augmentation processes for officers in year group 1997. Within the framework of the theory of human capital investment, this thesis incorporates Navy training data in the officer MOE analysis.

III. DATA AND METHODOLOGY

This section discusses the data that were compiled for investigating relationships between the explanatory variables and the MOEs as outlined by the thesis objectives in Chapter I. These relationships are modeled through statistical procedures. A review of the methodologies employed in deriving the research results concludes the chapter.

A. DATA

The data files used for this statistical analysis were obtained from two sources. The first source of data was Dr. William Bowman of the U.S. Naval Academy. He provided updated versions of the "Naval Officer Promotion History Data Files," derived from the Navy Officer Master Files, and extracts from the Navy Officer Loss files, which he had previously compiled through earlier research. These files, reflecting officer background, Navy experience, selection board results, and separation data, form the heart of this data set.

The second data source was NPRDC's Traintrack System Files, maintained by Dr. Michael Nikada, which added Navy training information to the basic data set. Although the subject of this research was the surface warfare officer

community, all officer communities, both line and staff, were included in the merged files to facilitate future research efforts.

The data from the O-3 (1981 to 1985) and O-4 (1985 to 1990) selection boards provide two career "snapshots" of an individual at the time of the board commencements. The data set is essentially the population of officers that was reviewed by the selection boards previously discussed, except for those personnel who had incomplete data records or who had separated from the Navy for reasons of death or medical disabilities. Only officers who were graduates of USNA, ROTC, or OCS were included in this study. Through the use of the officer warfare designator variable, the data set for this study was defined as surface warfare officers or surface warfare officer trainees. Nuclear power trained officers were included within this data set because no variables were available in the data set to identify them separately.

ROTC scholarship program graduates and ROTC contract (or college) program students were analyzed as a group because both contribute towards fulfilling the quota of graduates from a particular ROTC unit.

Figure 1 displays the groups of background factors and the variables associated with each group. These are the factors and variables that are used in the statistical models in Chapter IV.

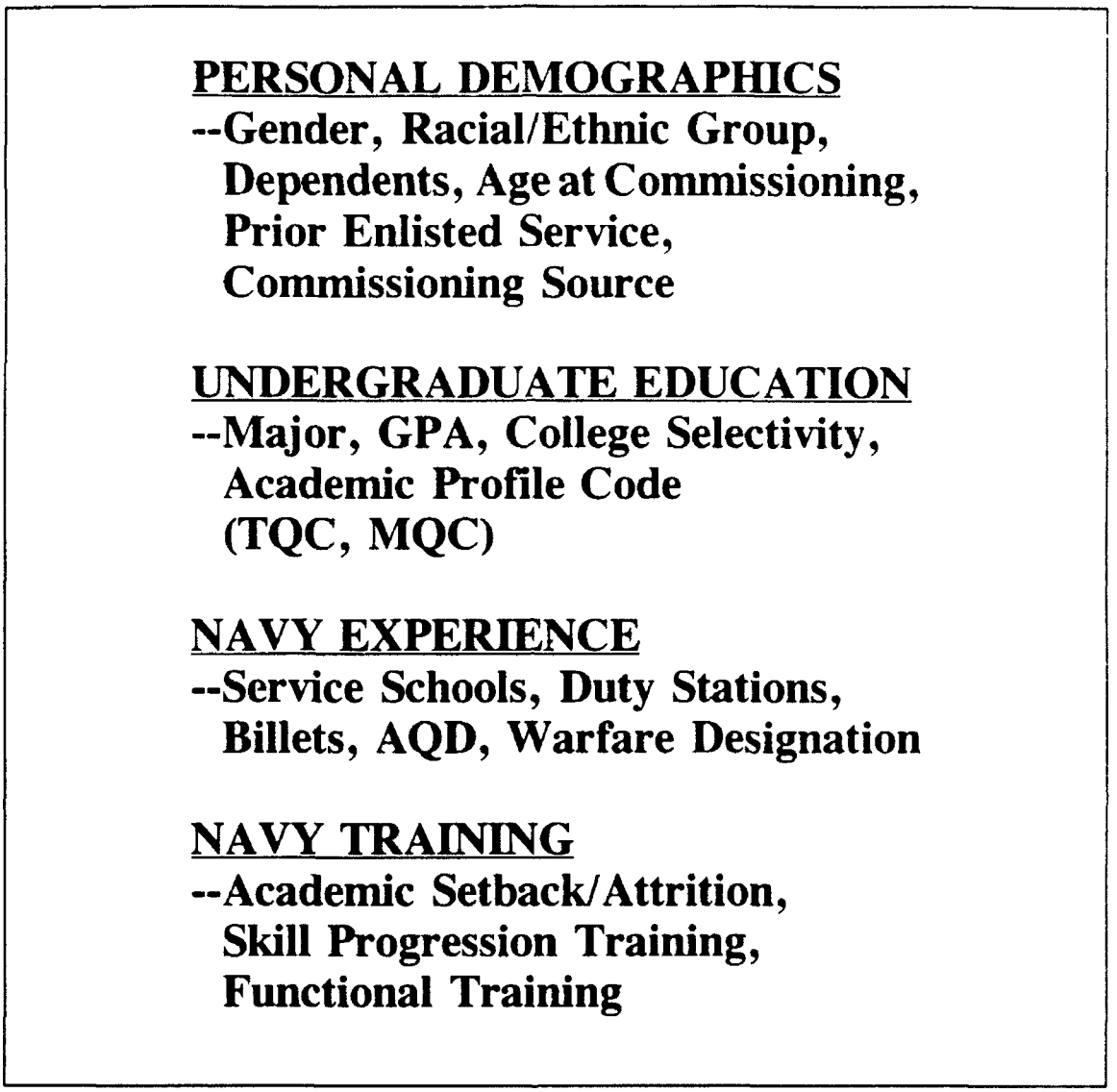

Figure 1. Background Factor Variable Categories For Early Qualifications, Retention, and Promotion Models

As seen in Figure 1 there are four broad categories of variables in this study. The first category concerns personal demographics. The racial/ethnic group is a binary variable signifying an individual's status as either a minority (black and other categories) or white. The number of dependents

information is broken down into single persons, persons with one dependent/spouse, or persons with more than one dependent. Age at commissioning is a continuous variable. The variable for prior enlisted service only includes those officers with more than one year of enlisted service. Thus, graduates of the accession source preparatory programs, such as the Naval Academy Preparatory School, are not included in the enlisted group since they are more likely to replicate the career characteristics of their commissioning source cohort group. The commissioning source variable identified the individual's accession program.

The second group of background factors contains information on the individual's undergraduate education. This study uses the academic major codes to differentiate an engineering major from all others. The grade point average (GPA) was broken out by "high" (3.2-4.0) versus all others.

Since the college selectivity categories are a critical portion of this study, their explanation will be in greater depth than the other less complex variables. The categories of college selectivity used in this study are based on *Barron's Profiles of American Colleges*. (Barron's Educational Series, Inc., 1991) Barron's criteria for determining the selectivity category for each college included:

- median entrance examines scores for recent freshman class (SAT/ACT),
- percentages of freshman class scoring above a designated SAT/ACT score,

- percentage incoming freshman ranked in the upper fifth and upper two fifths of high school class,
- college admissions policy on minimum standards for grade point average and class rank, and
- percentage of recent freshman class accepted. (Barron's Educational Series, Inc., 1991)

The "high" college selectivity category, representing Barron's "Most Competitive" and "Highly Competitive" categories, includes the U. S. Naval Academy as well as schools which may be classified as Ivy League or Stanford University equivalents. The "medium" college selectivity category, representing the Barron's "Very Competitive" category, contains private and state schools which are not as selective as the high category. Lastly, the "less" selective category, representing the Barron's "Competitive" and "Less Competitive" categories, contains the larger state schools and small private colleges, some of which have special educational missions.

Other information contained within the undergraduate background factor category includes the remaining components of the academic profile codes. The academic profile code (APC) is a three-digit code that summarizes portions of an individual's undergraduate academic performance. In addition to the GPA previously discussed, other areas of academics are quantified. The Mathematic Qualification Code (MQC) reflects academic background and performance in calculus-related mathematics courses. The Technical Qualification Code (TQC)

measures performance in science or engineering courses. For the purpose of this study, an individual with a high MQC, signifying significant post-calculus math with grades of B or higher or completion of a calculus course sequence with a B+ or better, was modelled. Similarly, an individual with a high TQC which signified pertinent upper-division technical courses with an average of B+ or higher or significant pertinent upper-division technical sources with an average between C+ and B, were modeled.

The third group of background factors represented information dealing with an individual's Navy experience. SWO Department Head School is the most important service school in this category. The duty station variables permit calculation of the number of sea tours for an individual. The billets, representing data from the Naval Officer Billet Codes (NOBC), were used only in the O-4 Promotion model due to inaccuracies in reporting specific billet assignment below the department head level onboard ship. The additional qualification designator (AQD) data provides critical information for analysis in the three models. The four-digit warfare designations are used to delineate the SWO community from the other officer communities in the data files.

Under the broad category of Navy training, three variables were derived from the Traintrack System files to replicate differences in specific training investment and a student training success indicator. The Academic Setback/Attrition

variable indicates whether or not the individual has had an academic setback or has been attrited from a Navy training course. This variable provided an indication of an individual's training ability and prior academic achievement.

The second training variable is the number of Skill Progression Training instruction days. Skill progression training provides advanced knowledge, skills, and techniques required to perform a particular job in a billet. It is typically twelve or more calendar days in length.

The third training variable represented the number of Functional Training instruction days. Functional training provides team training or individual training such as refresher training, operator, maintenance, or technical training of less than twelve calendar days and is established to meet the needs of the fleet or type commanders.

Since the Traintrack system course cost data only dates back to 1986, it was not suitable for the personnel in this data set (which extends back to commissioning year group 1976). To reflect the organizational investments or opportunity costs of Navy training, the number of instructional days is used as a continuous variable for the regression analysis.

B. METHODOLOGY

The purpose of this thesis is to empirically examine differences in officer performance as related to commissioning source, undergraduate education, and Navy training. This section describes the three MOE models and their associated submodels.

Figure 2 introduces the modelling methodologies for the three MOE models. The MOE models reflect the different types of human capital investments and show which explanatory variables are important contributory factors in explaining the outcome of the models. The four groups of explanatory variables which form the basis of the models are illustrated below. Early professional qualification, retention between O-3 and O-4 selection boards, and promotion to O-4 have been modeled for the surface warfare officer community utilizing non-linear logit models. The dependent variables of the three models are binomial. Each of the models are discussed in detail beginning with the early professional qualifications model.

Three logit models of SWO career path:

1. **QUAL = f (DEMOG, COLL, EXP, TRAIN)**
2. **RET = f (DEMOG, COLL, EXP, TRAIN)**
3. **PROMO = f (QUAL*, DEMOG, COLL, EXP)**

Where,

QUAL = early professional qualifications

RET = retention between O-3 and O-4 selection boards

PROMO = promotion to O-4

DEMOG = personal demographic variables

COLL = undergraduate education variables

EXP = Navy experience variables

TRAIN = Navy training variables

QUAL* substituted in PROMO model to show indirect effect of Navy training.

Figure 2. Modeling Methodology

Early Professional Qualification (QUAL*) based on an individual who earned AQDs reflecting qualification as a surface warfare officer, engineering officer of the watch, or officer of the deck (underway). The individuals within this model were either SWO qualified, SWO trainees, or were previously one of the two officer community designators at the

O-3 selection boards. Variables for undergraduate major, TQC and MQC were not included in this model because preliminary analysis revealed a negative effect between the upper quality measurement for these variables and attainment of the early professional qualifications. This negative effect was attributed to the reduced opportunity by the third year of service for nuclear trained officers to attain their professional qualifications. This is due to the lengthy schooling required prior to shipboard duty, which places nuclear trained officers onboard approximately twelve to eighteen months after their contemporaries who are conventional SWO trainees.

Retention is examined as a measure of effectiveness to state whether or not an individual remained in the service. A separate analysis whether retention reflects organizationally-directed (or involuntary) as well as voluntary separation, are not within the purview of this study. The intervening years between the O-3 and O-4 selection boards are the focus of the retention model because that is the point when most military service requirements (MSR) are satisfied. Through analysis of the intervening period, differences in MSR reflective of commissioning program and service selection can be compensated for. In summary, the retention model looks at the stay/leave decision and relates it back to the measurable characteristics of the O-3 selection board data set.

The promotion to O-4 model looked at individuals who were SWO or SWO trainees at the O-3 selection boards, stayed in the service, and remained within the SWO community. The data do not represent former SWOs who laterally transferred out of the SWO community into other line and staff officer communities. Since each officer community has a slightly different framework to gauge promotion potential to O-4, only the SWO selection board results are reviewed.

The O-4 promotion model is different from the other two in that it reviews individuals who have reached eight to ten years of service, as opposed to the O-3 selection board at three years of service. There are many more qualifications that may be examined, as well as other Navy experience data. Shipboard department head billet types and graduation status from Department Head School are reviewed in this model. Furthermore, the Early Professional Qualifications variable (Qual) is used to indirectly account for the impact of Navy training investments in the O-4 promotion model. It also provides the opportunity to determine if there is any predictive correlation between early professional qualification attainment and later selection to O-4 and the transition into the career force.

In addition to the three basic models, samples are further broken down by college selectivity to determine if there are any changes in the impacts of the explanatory variables when the college selectivity is controlled for. These subsamples

also have implications for future downsizing in that they are distinct educational categories where investment decisions in undergraduate education are being made by the individual and by the Navy. For example, tuition costs tend, on the average, to be higher for the higher selectivity school.

IV. EMPIRICAL ANALYSIS

A. BIVARIATE ANALYSIS

The bivariate analysis of the data involves an examination of the frequency distribution of the dependent and explanatory variables used in the three logit models. Cross-tabulation of those variables provides insight into trends contained in the data. In this study the dependent variables modeled were cross-tabulated against commissioning source and college selectivity.

Figure 3 provides a cross-tabulation of early professional qualifications attainment, by college selectivity and commissioning source. In viewing Figure 3 it can be seen that when all of the commissioning sources are tabulated, USNA's 47.1 percent MOE attainment rate of early qualifications exceeds OCS at 45.7 percent and ROTC at 42.4 percent. Figure 3 also illustrates the differences within accession sources, such as OCS, when further defined by college selectivity. For example, MOE attainment is approximately nine percentage points higher for OCS graduates of highly selective schools as compared to OCS graduates from less selective schools. Although ROTC had the lowest attainment percentage, it had less than three percentage point variation, when analyzed by college selectivity.

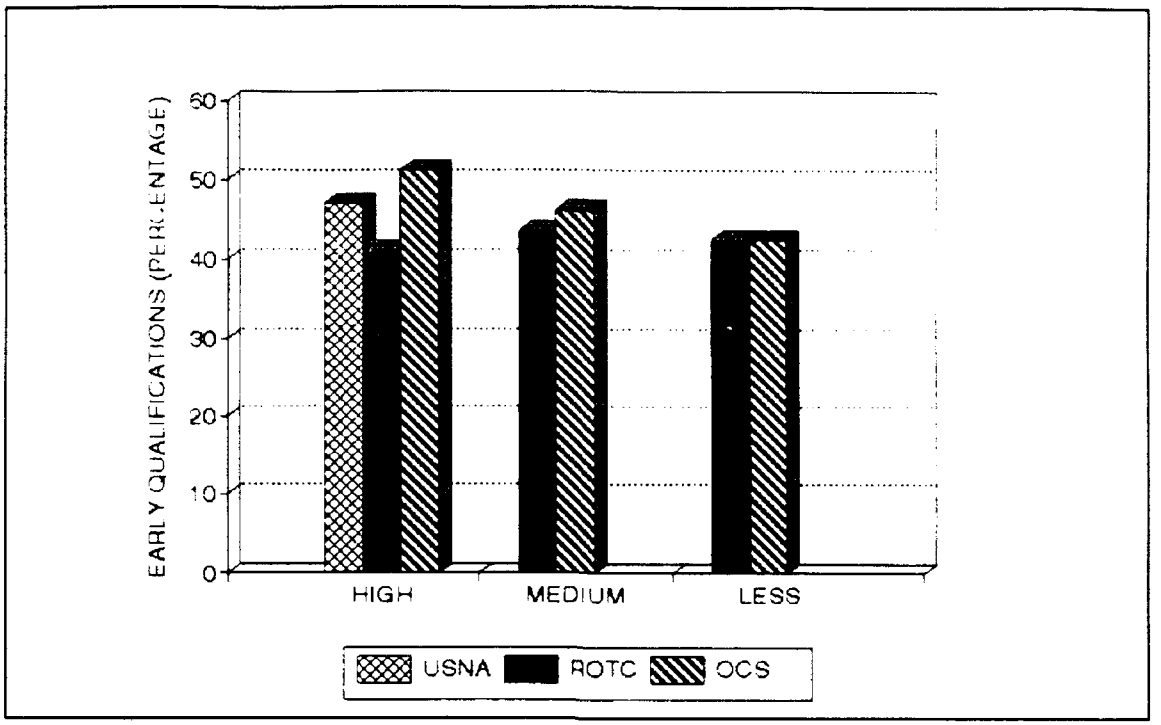

Figure 3. Percentage of Officers With Early Professional Qualifications At O-3 Selection Boards, By College Selectivity and Commissioning Source, 1981-1985

An additional perspective from Figure 3 is the fact that only 45 percent of the officers had attained the qualifications. Either there is a lengthy delay in Navy Officer Master File record updates or over half of the officers are still working on their basic qualifications. If this is true, then implications for the future officer augmentation process can be drawn. Using the O-3 selection board data, it can be thus demonstrated that there are a large numbers of officers who have not become fully productive after three years of service. This fact would support moving the

augmentation process back to the fourth or fifth year of service, when more information is available for analysis.

Table II displays the description of the variables and their means for the early professional qualifications model.

Table II. DESCRIPTIVE STATISTICS FOR VARIABLES IN EARLY PROFESSIONAL QUALIFICATIONS MODEL*

EXPLANATORY VARIABLES	MEAN/STANDARD DEVIATION
ONE DEPENDENT	.316 (.465)
OCS GRADUATE	.469 (.499)
ROTC GRADUATE	.271 (.445)
ENLISTED SERVICE (GREATER THAN ONE YEAR)	.287 (.452)
HIGHLY SELECTIVE COLLEGE	.376 (.484)
MALE	.983 (.131)
WHITE	.925 (.264)
HIGH GPA (3.2-4.0)	.168 (.374)
MORE THAN ONE SEA TOUR	.155 (.362)
ACADEMIC SETBACK/ATTRITION	.066 (.248)
FUNCTIONAL TRAINING DAYS	7.765 (10.600)
SKILL PROGRESSION TRAINING DAYS	45.027 (54.257)
AGE AT COMMISSIONING (IN YEARS)	23.558 (2.833)
EARLY PROFESSIONAL QUALIFICATION	.452 (.498)

* ALL VARIABLES IN PERCENT EXCEPT AGE AT COMMISSIONING, FUNCTIONAL TRAINING DAYS, AND SKILL PROGRESSION TRAINING DAYS.

The majority of naval officers in this sample are white male graduates of either ROTC or OCS. Over 45 percent of this naval officer sample had attained their early professional qualifications. A review of possible officer quality indicators reveals that approximately 17 percent had high GPAs and over 37 percent had attended a highly selective

undergraduate institutions. The other end of the quality spectrum is represented by the 6.6 percent who had been setback or had attrited from a Navy training course.

Figure 4 illustrates the percentages of officers who remained in the service between the O-3 and O-4 selection boards. This is the career time frame when the initial service obligations are fulfilled and the individual officer has the opportunity to resign from the Navy. When commissioning sources are aggregated, OCS graduates remained in the service at a rate of 48.6 percent, followed by USNA graduates at the 45.6 percent, and ROTC graduates with 44.75 percent. Thus, by accession sources there does not appear to be any differences in the officer retention model. However, once undergraduate education factors are incorporated into the bivariate analysis, some large differences do appear by college selectivity and commissioning program. Within the highly selective college category, USNA had the highest retention at 45.6 percent as compared to ROTC at 31 percent and OCS at 21 percent. The medium college selectivity category has the highest retention among ROTC graduates with a 55.6 percent retention rate and OCS graduates at a 49 percent retention rate. Among the less selective colleges, the ROTC retention rate of 34.2 percent closely parallels the rate of the ROTC retention from this highly selective category. This contrasts sharply with OCS retention from less

selective colleges graduates who remain at the 55.7 percent rate.

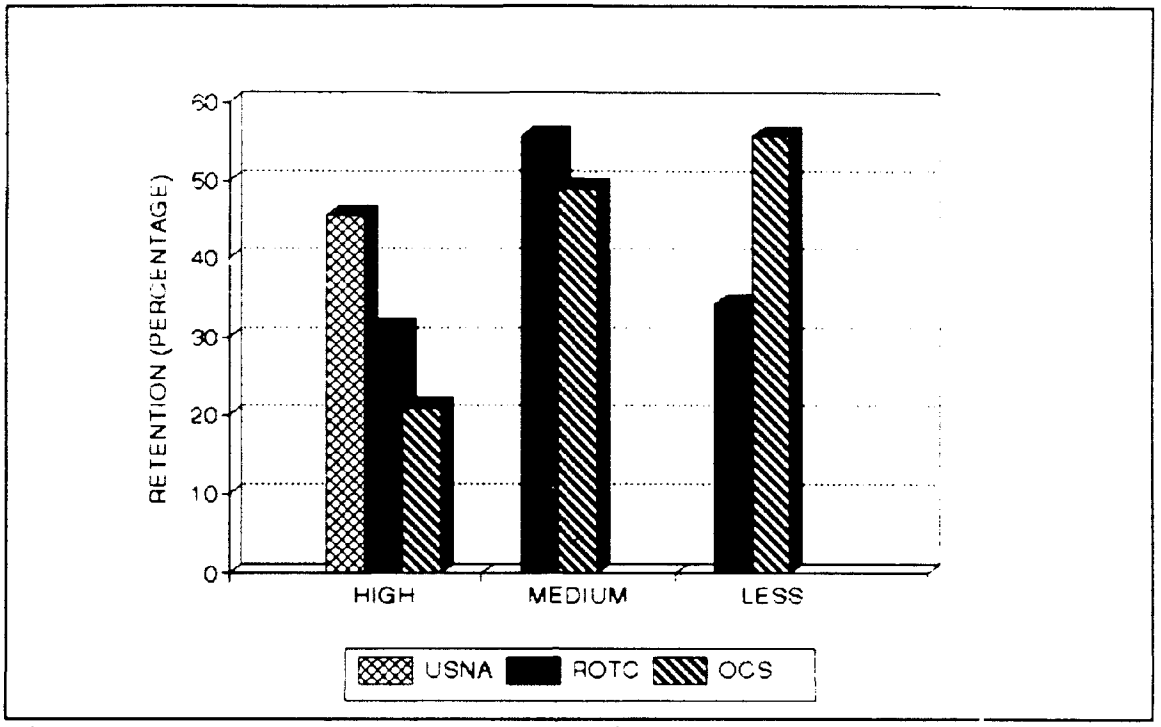

Figure 4. Percentage of Officer Retention, By College Selectivity And Commissioning Source Between O-3 And O-4 Selection Boards, 1981-1990

These retention statistics are not analyzed to determine if the reason for separation was a voluntary or involuntary. The overall display provides an indication of which commissioning sources provide returns on human capital investments made by the individual and the Navy.

Table III lists information on the variables included in the retention model. The variables and their associated statistics are similar to those listed in Table II because, in both instances, comparisons were made from the O-3 selection

board samples. The retention model includes additional variables that represent undergraduate courses of study and associated measures of academic achievement. This is evidenced by 12 percent of the sample having high Technical Qualification Codes and the 14 percent having high Math Qualification Codes. Twenty-eight percent of the group graduated with engineering undergraduate degrees. An examination of professional qualifications reveals that 42 percent of tne group are surface warfare qualified. Finally, the separation data indicate that over half of the officers left the Navy in the years prior to their O-4 selection board.

Figure 5 displays the percentages of officers not promoted by commissioning source and college selectivity categories. In contrast to the two earlier MOE, this is an organizationally controlled career milestone. It is at this point where promotion criteria are intertwined with the overall organizational goals. The O-4 promotion board is the transition point for naval officer to enter the career force. Additionally, this boara take place after the retention decision has already been made, therefore the sample is more homogenous than was found at the O-3 selection board.

As seen in the previous figures, differences by accession source and college selectivity category can be found. In the high selectivity category, the OCS graduates who remained in the Navy promote at the same rate as USNA graduates. There is no explanation for the seven percent higher fail to promote

Table III. DESCRIPTIVE STATISTICS FOR VARIABLES IN RETENTION MODEL*

EXPLANATORY VARIABLES	MEAN/STANDARD DEVIATION
ONE DEPENDENT	.316 (.465)
OCS GRADUATE	.469 (.499)
ROTC GRADUATE	.271 (.445)
ENLISTED SERVICE (GREATER THAN ONE YEAR)	.287 (.452)
HIGHLY SELECTIVE COLLEGE	.376 (.484)
MALE	.983 (.131)
WHITE	.925 (.264)
HIGH GPA (3.2-4.0)	.168 (.374)
HIGH TECHNICAL QUALIFICATION CODE	.119 (.324)
HIGH MATH QUALIFICATION CODE	.140 (.347)
TECHNICAL UNDERGRADUATE MAJOR	.287 (.452)
MORE THAN ONE SEA TOUR	.155 (.362)
ENGINEERING OFFICER OF THE WATCH	.072 (.258)
OFFICER OF THE DECK (UNDERWAY)	.055 (.228)
SURFACE WARFARE OFFICER	.418 (.493)
ACADEMIC SETBACK/ATTRITION	.066 (.248)
FUNCTIONAL TRAINING DAYS	7.765 (10.600)
SKILL PROGRESSION TRAINING DAYS	45.027 (54.257)
AGE AT COMMISSIONING (IN YEARS)	23.558 (2.833)
LEAVERS BETWEEN O-3/O-4 SELECTION BOARDS	.532 (.499)

* ALL VARIABLES IN PERCENT EXCEPT AGE AT COMMISSIONING, FUNCTIONAL TRAINING DAYS, AND SKILL PROGRESSION TRAINING DAYS.

rate for ROTC graduates. This difference could possibly be related to earlier officer selectivity screening model differences.

The medium selectivity category individuals promote at approximately the same rate, but at a six percent lower rate in comparison to USNA and OCS high selectivity college graduates. Promotion differences of six percentage points are

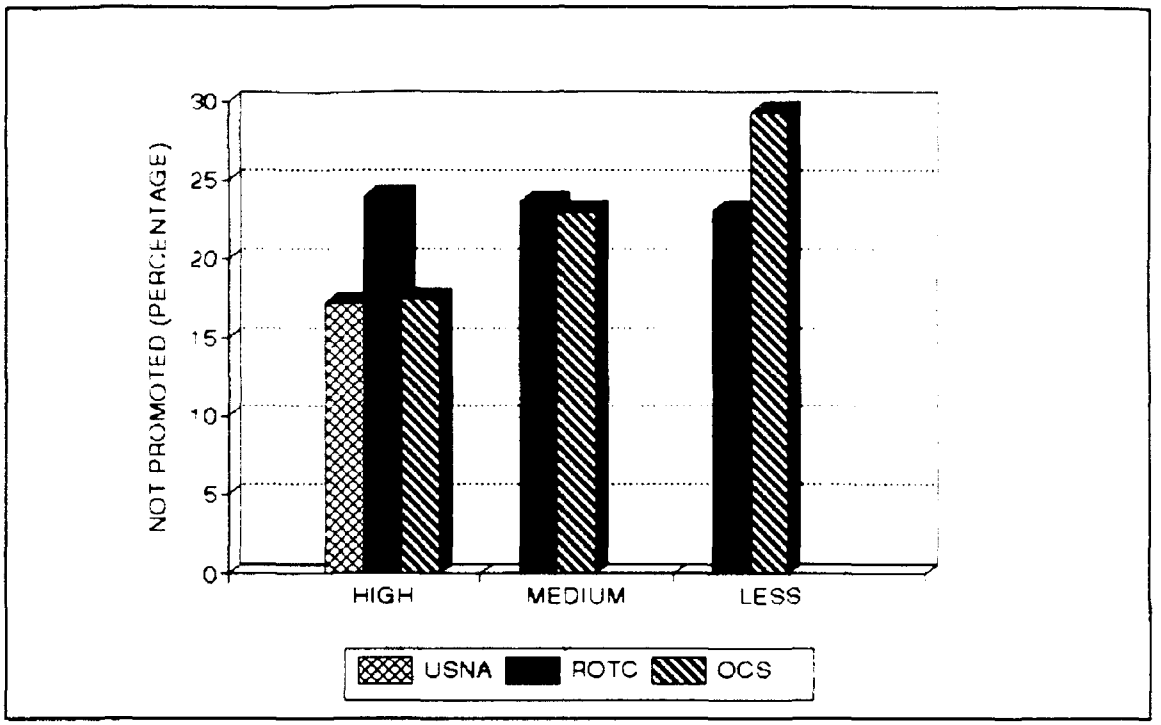

Figure 5. Percentage of Officers Who Were Not Promoted To O-4, By College Selectivity and Commissioning Source, 1985-1990

found in the less selective college category between OCS and ROTC graduates. This difference highlights the organizationally-directed selection into the career force.

Overall, two trends are revealed by Figure 5. The first one is that ROTC graduates, when analyzed across selectivity categories, have less than one percent point promotion variation. In sharp contrast, OCS graduates whose failure to promote percentages varied from 17.5 percent for highly selective to 29.3 percent for less selective colleges. Each category has approximately a six percentage point lower promotion rate than the one preceding it. This trend shows that the greatest differences occur across college selectivity

categories. Once again, the differences may be related to the differences in the commissioning program screening models and the missions of the accession sources.

Table IV. DESCRIPTIVE STATISTICS FOR VARIABLES IN PROMOTION MODEL*

EXPLANATORY VARIABLES	MEAN/STANDARD DEVIATION
SINGLE, NO DEPENDENTS	.210 (.408)
OCS GRADUATE	.426 (.495)
ROTC GRADUATE	.281 (.450)
ENLISTED SERVICE (GREATER THAN ONE YEAR)	.283 (.450)
HIGHLY SELECTIVE COLLEGE	.402 (.491)
MALE	.981 (.136)
WHITE	.919 (.272)
HIGH GPA (3.2-4.0)	.134 (.340)
HIGH TECHNICAL QUALIFICATION CODE	.099 (.299)
HIGH MATH QUALIFICATION CODE	.116 (.321)
TECHNICAL UNDERGRADUATE MAJOR	.272 (.445)
MORE THAN TWO SEA TOURS	.496 (.500)
ENGINEERING OFFICER OF THE WATCH	.415 (.493)
SWO DEPARTMENT HEAD SCHOOL GRADUATE	.727 (.446)
TACTICAL ACTION OFFICER	.310 (.462)
COMBAT SYSTEMS OFFICER	.079 (.270)
OPERATIONS OFFICER (NTDS)	.077 (.267)
FAILED TO PROMOTE	.212 (.409)
AGE AT COMMISSIONING (IN YEARS)	23.377 (.654)
EARLY PROFESSIONAL QUALIFICATIONS	.601 (.490)

* ALL VARIABLES IN PERCENT EXCEPT AGE AT COMMISSIONING, FUNCTIONAL TRAINING DAYS, AND SKILL PROGRESSION TRAINING DAYS.

Descriptive statistics and explanations of the variables in the promotion model are found in Table IV. Although the

sample size is smaller due to attrition and lateral transfers out of the SWO community, the explanatory variables incorporate more Navy experience information due to the increased time in service. Of particular note, is the inclusion of the Early Professional Qualification variable (QUAL*) in the promotion model.

In Table IV the descriptive statistics show once again that the sample group remains for the most part white male. The percentage of officers from highly selective colleges increases 3 percentage points which reflects higher retention of USNA graduates. Sixty percent of this group had achieved early qualifications at the O-3 selection board as compared to the forty-five percent qualification rate at the O-3 selection board. Finally, almost three-quarters of the group are department head school graduates and half have more than two operational tours at sea.

In concluding the bivariate analysis, the figures illustrate differences in the three MOE models attributable to differences in commissioning source and college selectivity. The other explanatory variables listed in the tables were not held constant in the bivariate analysis. Thus, this form of analysis reveals areas for further, more detailed study, in order to incorporate the effects of all of the explanatory variables. It is this area of research which will be examined in the multivariate analysis section.

B. MULTIVARIATE ANALYSIS

Multivariate logit models were estimated by maximum likelihood techniques using early professional qualification, retention, and promotion as dependent variables. Each model was estimated for a pooled sample consisting of all commissioning sources and college selectivity levels and then separately by commissioning source and by college selectivity level. This section presents the overall results for the three primary models and their corresponding submodels.

The tables provide the signs and magnitudes of the estimated coefficients for the logit models specified. The standard error of the coefficient estimates are listed in parentheses. The calculated change in probabilities associated with a one unit change in each explanatory variable are also displayed for the primary models to aid in the interpretation of the logit coefficients. The changes in the probabilities were obtained from OLS estimates of the models.

Table V displays the results of the logit estimates for the early professional qualifications model. In this pooled model, seven explanatory variables are statistically significant in affecting early qualification attainment. Compared to USNA graduates, both OCS and ROTC graduates are less likely to attain early professional qualifications. The coefficient for ROTC graduates is significant at the .01 level. Officers that experienced an academic setback or attrition from a Navy training course also are less likely to

attain early qualifications. The variables representing one dependent, whites, and having more than one sea tour have a positive effect in early qualification attainment. Perhaps of particular importance, all three of the Navy training variables are significantly associated with early professional qualification attainment.

In reviewing the signs of the coefficients for the statistically significant variables, it can be seen that the variables for persons having one dependent and having had more that one sea tour have the largest changes in probabilities associated with them. In particular, married persons have a 28 percent higher probability of attaining early qualifications, and those with more than one sea tour have a 13 percent higher probability. These probability changes are larger than would be normally expected. Officers who had received an academic setback or attrited were nine percent less likely to attain early qualification. The magnitude of the effects of the training variables are fairly small, less than one percent, but they are based on a change of only one day of training.

In terms of the goodness-of-fit of the model, the likelihood ratio chi-square test statistic, 257.718, tests the joint significance of all of the explanatory variables included in the model. In this case it is significant at the .0001 level. The concordance ratio provides a measure of the

predictive ability of the model. In this case the ratio is .619. Overall, the model seems to fit the data well.

Table V. LOGIT ESTIMATES OF THE EARLY PROFESSIONAL QUALIFICATIONS MODEL[1]

INDEPENDENT VARIABLES	COEFFICIENT ESTIMATE	CHANGE IN PROBABILITY[2]
ONE DEPENDENT	.206 (.054)**	.281
OCS GRADUATE	-.005 (.107)	-.050
ROTC GRADUATE	-.163 (.091)**	-.001
ENLISTED SERVICE (GREATER THAN ONE YEAR)	-.028 (.066)	-.006
HIGHLY SELECTIVE COLLEGE	.033 (.083)	.009
MALE	-.070 (.192)	-.016
WHITE	.318 (.099)**	.073
HIGH GPA (3.2-4.0)	-.001 (.068)	-.003
MORE THAN ONE SEA TOUR	.532 (.069)**	.131
ACADEMIC SETBACK/ATTRITION	-.416 (.106)**	-.096
FUNCTIONAL TRAINING DAYS	.021 (.003)**	.004
SKILL PROGRESSION TRAINING DAYS	.004 (.001)**	.001
AGE AT COMMISSIONING (IN YEARS)	.004 (.011)	.001
INTERCEPT	.934 (.345)	--
CHI-SQUARE (LIKELIHOOD RATIO TEST)	257.718	
CONCORDANCE RATIO[3]	.619	
SAMPLE SIZE	6,808	

[1] STANDARD ERROR IN PARENTHESES.
[2] FROM ORDINARY LEAST SQUARES ESTIMATION.
[3] IS A MEASURE OF THE PREDICTIVE ABILITY OF THE MODEL.
* SIGNIFICANT AT THE .05 LEVEL.
** SIGNIFICANT AT THE .01 LEVEL.

Table VI displays the early professional qualification submodels estimated separately for the three college

selectivity categories. Among the highly selective college graduates, ROTC has a negative effect on early qualification attainment. Variables which have significant positive effects include one dependent, functional training, and greater than one sea tour, all of which were also significant and had the same signs in the pooled grouping.

Because USNA graduates were not included in either the medium or low selectivity groups, ROTC is compared to OCS. This is a different comparison than that in column 1, which uses USNA as the comparison group. In columns 2 and 3 there are no significant differences in performance between OCS and ROTC graduates.

Within the medium selective category, variables which have significant positive effects include one dependent, functional training, and greater than one sea tour, all of which were also significant in the pooled grouping. Within the medium selective category, whites are more likely to attain early qualification. All of the Navy training variables are significant in the medium selectivity model. The first area is in the skill progression training which has a positive effect. A negative effect is associated with the academic setback/attrition variable. In addition to demonstrating a lack of academic success in the Navy training environment, the academic setback/attrition variable has predictive value for an individual's on the job performance, as measured by the failure to achieve early qualifications.

Table VI. LOGIT ESTIMATES OF THE EARLY PROFESSIONAL QUALIFICATIONS MODEL BY COLLEGE SELECTIVITY[1]

	COLLEGE SELECTIVITY		
INDEPENDENT VARIABLES	HIGH	MEDIUM	LESS
ONE DEPENDENT	.267 (.086)**	.208 (.082)*	-.001 (.150)
OCS GRADUATE	.199 (.165)	[2]	[2]
ROTC GRADUATE	-.278 (.104)**	-.179 (.110)	.064 (.198)
ENLISTED (> ONE YEAR)	.119 (.138)	-.124 (.091)	.105 (.164)
MALE	.029 (.288)	-.097 (.292)	.830 (.736)
WHITE	.124 (.149)	.593 (.184)**	.327 (.221)
HIGH GPA (3.2-4.0)	-.112 (.116)	.013 (.100)	.047 (.185)*
MORE THAN ONE SEA TOUR	.902 (.129)**	.414 (.097)**	.146 (.182)
ACADEMIC SETBACK/ATTRITE	.064 (.213)	-.575 (.154)**	-.340 (.240)
FUNCTIONAL TRAINING DAYS	.015 (.004)**	.022 (.004)**	.023 (.008)**
SKILL PROGRESSION DAYS	.001 (.001)	.007 (.001)**	.006 (.001)**
AGE AT COMMISSIONING	-.060 (.041)*	.005 (.015)	-.006 (.025)
INTERCEPT	-.725 (.946)	1.232 (.510)	1.808 (1.010)
CHI-SQUARE (LIKELIHOOD RATIO TEST)	91.437	181.253	42.967
CONCORDANCE RATIO[3]	.615	.641	.629
SAMPLE SIZE	2562	3029	926

[1] STANDARD ERROR IN PARENTHESES.
[2] MODEL BASE CASE CONDITION.
[3] IS A MEASURE OF THE PREDICTIVE ABILITY OF THE MODEL.
* SIGNIFICANT AT THE .05 LEVEL.
** SIGNIFICANT AT THE .01 LEVEL.

For individuals in the less selective college category, investments in functional and skill progression training had positive effects similar to the medium selectivity sample. However, the only other statistically significant explanatory variable is possession of a high GPA. Overall, Navy training

variables had a greater impact in explaining early professional qualifications attainment for medium and less selective college graduates than for highly selective college graduates. This seems to suggest that there are substitution possibilities between the quality of the institution and the subsequent in-house training; at least for skill progression training.

Reviewing the signs and magnitudes of the coefficients between the submodel categories shows that the subsample groups have differing characteristics. Comparing the log likelihood ratio test and concordance ratios, Table V and Table VI reveal that the models also have different predictive abilities. In the case of the early qualifications model, the pooled sample has a higher chi-square value and concordance ratio. Among the submodels, the log likelihood chi-square value is the greatest for the medium selective category.

Table VII displays the results of the logit estimation of the retention model. In the pooled model, eleven of the nineteen explanatory variables are statistically significant in predicting retention between the O-3 and the O-4 selection boards. The variables for one dependent, high GPA, high TQC, technical major, and age at commissioning all had positive effects. Additionally, the following six variables are negatively associated with retention and are statistically significant: white, OCS graduate, ROTC graduate, highly selective school, academic setback/attrition, and prior

enlisted service. These variables reflect differences in retention which were first reviewed in the bivariate analysis section. The Navy training variables were not significant except in the case of identifying individuals who had not met minimum training standards. OCS and ROTC, which had negative effects in predicting retention, confirmed the pattern of differences seen in the bivariate analysis.

OCS and ROTC graduates are respectively 21 and 16 percent less likely to stay than USNA graduates. On the other hand, those from highly selective colleges are 21 percent less likely to stay. Whites are 11 percent less likely to stay. Those who suffered academic setbacks are 4 percent less likely to stay. The log likelihood chi-square value of 268.74 and the concordance ratio of .605 reinforce the expectation of the high predictive ability of this model.

Table VII. LOGIT ESTIMATES OF THE RETENTION MODEL[1]

INDEPENDENT VARIABLES	COEFFICIENT ESTIMATE	CHANGE IN PROBABILITY[2]
ONE DEPENDENT	.009 (.054)**	.022
OCS GRADUATE	-.927 (.114)**	-.211
ROTC GRADUATE	-.716 (.096)**	-.161
ENLISTED SERVICE (GREATER THAN ONE YEAR)	-.112 (.066)**	-.027
HIGHLY SELECTIVE COLLEGE	-.941 (.089)**	-.215
MALE	.079 (.194)	.017
WHITE	-.477 (.097)**	-.115
HIGH GPA (3.2-4.0)	.217 (.071)**	.052
HIGH TECHNICAL QUALIFICATION CODE (4,5)	.163 (.086)**	.039
HIGH MATH QUALIFICATION CODE (5,6)	-.132 (.081)	-.031
TECHNICAL UNDERGRADUATE MAJOR	.153 (.065)*	.036
MORE THAN ONE SEA TOUR	.025 (.069)	.006
ENGINEERING OFFICER OF THE WATCH	.040 (.097)	.009
OFFICER OF THE DECK (UNDERWAY)	.023 (.111)	.006
SURFACE WARFARE OFFICER	-.069 (.053)	-.017
ACADEMIC SETBACK/ATTRITION	-.184 (.103)**	-.044
FUNCTIONAL TRAINING DAYS	-.002 (.002)	-.001
SKILL PROGRESSION TRAINING	-.001 (.001)	-.001
AGE AT COMMISSIONING	.088 (.012)**	.021
INTERCEPT	-.874 (.721)	--
CHI-SQUARE (LIKELIHOOD RATIO TEST)	268.740	
CONCORDANCE RATIO[3]	.605	
SAMPLE SIZE	6,808	

[1] STANDARD ERROR IN PARENTHESES.
[2] FROM ORDINARY LEAST SQUARES ESTIMATION.
[3] IS A MEASURE OF THE PREDICTIVE ABILITY OF THE MODEL.
* SIGNIFICANT AT THE .05 LEVEL.
** SIGNIFICANT AT THE .01 LEVEL.

Table VIII displays the retention submodels which analyze college selectivity categories separately. In all of the models the continuous variable age at commissioning was significant and positive. In the highly selective college submodel, there are no significantly positive variables with the exception of the age at commissioning variable.
The significant variables with negative coefficients are whites, ROTC graduate, and OCS graduate. These variables were also significant in the pooled model.

In the medium selective category, ROTC graduate is positively correlated with retention (as compared to OCS graduates), as are variables for high GPA, age at commissioning, one dependent, and a technical undergraduate major. The variables that are negatively associated with retention are surface warfare qualified and white.

In the less selective college submodel, high GPA and age at commissioning are the only variables that were statistically significant with positive effects. The ROTC graduate variable is significant but now has a negative effect on retention (compared to OCS graduates). Thus, among medium selective schools, ROTC graduates are more likely (than OCS graduates) to stay, but among the least selective schools they are less likely to stay. The Navy training variable for academic setback/attrition was negative (and significant) in predicting retention.

The log likelihood test statistic varies by model in Table VIII. The value of the log chi-squares decreases from 112.496 for the high selectivity submodel to 62.682 for the less selective model. The concordance ratio varies from .588 for the medium selective model to .646 for the less selective model. Possibly the explanatory variables in the models have a greater predictive ability for the high selectivity submodel than for the less selective submodel.

Table VIII. LOGIT ESTIMATES OF THE RETENTION MODEL BY COLLEGE SELECTIVITY[1]

INDEPENDENT VARIABLES	COLLEGE SELECTIVITY		
	HIGH (N = 2562)	MEDIUM (N = 3029)	LESS (N = 926)
ONE DEPENDENT	.124 (.087)	.144 (.081)**	-.099 (.151)
OCS GRADUATE	-1.184 (.109)**	[2]	[2]
ROTC GRADUATE	-.568 (.109)**	.432 (.113)**	-.672 (.205)**
ENLISTED (> ONE YEAR)	-.173 (.145)	-.113 (.090)	.011 (.163)
MALE	.107 (.307)	-.218 (.286)	.857 (.731)
WHITE	-.706 (.149)**	-.417 (.172)*	-.335 (.218)
HIGH GPA (3.2-4.0)	.137 (.130)	.226 (.103)*	.405 (.198)*
HIGH TQC	.158 (.114)	.086 (.157)	.043 (.294)
HIGH MQC	.001 (.113)	-.135 (.139)	-.339 (.289)
TECHNICAL MAJOR	.086 (.090)	.221 (.115)**	.152 (.212)
MORE THAN ONE SEA TOUR	.129 (.129)	-.019 (.096)	.113 (.184)
EOOW	.044 (.155)	.084 (.148)	-.195 (.271)
OFFICER OF THE DECK (U/W)	.202 (.177)	-.050 (.166)	.100 (.331)
SURFACE WARFARE OFFICER	-.008 (.088)	-.017 (.078)*	.104 (.146
ACADEMIC SETBACK/ATTRITE	-.253 (.224)	-.057 (.145)	-.583 (.238)*
FUNCTIONAL TRAINING DAYS	-.002 (.003)	-.002 (.004)	-.007 (008)
SKILL PROGRESSION DAYS	.001 (.001)	-.001 (.001)	-.002 (.001)
AGE AT COMMISSIONING	.101 (.044)*	.092 (.015)**	.062 (.025)*
INTERCEPT	-2.000 (1.000)	-1.678 (.500)	-1.835 (1.000)
CHI-SQUARE (LIKELIHOOD RATIO TEST)	122.493	79.070	62.682
CONCORDANCE RATIO[3]	.618	.588	.646
SAMPLE SIZE	2562	3029	926

[1] STANDARD ERROR IN PARENTHESES.
[2] MODEL BASE CASE CONDITION.
[3] IS A MEASURE OF THE PREDICTIVE ABILITY OF THE MODEL.
* SIGNIFICANT AT THE .05 LEVEL.
** SIGNIFICANT AT THE .01 LEVEL.

Table IX displays the results of the logit equation for the primary MOE, promotion to O-4. In this model, the effects of Navy training are indirectly measured through the inclusion of the early professional qualification variable. The following eight variables are positive and significant: early professional qualifications, high GPA, high TQC, engineering officer of the watch qualified, tactical action officer qualified, department head school graduate, served in a combat systems officer department head billet, and served in an operations officer (NTDS) department head billet. Negative effects are associated with single persons, age at commissioning, and males.

The pooled model for promotion has the largest chi-square value and concordance ratio of any of the models reviewed thus far. It signifies that among the other variables, this model specification has the greatest predictive power. Also displayed are the relatively large coefficient estimations for four of the significant variables. SWO department head school graduates having served as a combat systems officer, operations officer (NTDS), or tactical action officer reveal the largest positive changes in probability values, 28, 7, 10, and 8 percent respectively. Males are 20 percent less likely to be promoted than females, and whites 4 percent more likely than minorities. There are no significant differences between commissioning source and school selectivity.

Table IX. LOGIT ESTIMATES OF THE PROMOTION MODEL[1]

INDEPENDENT VARIABLES	COEFFICIENT ESTIMATE	CHANGE IN PROBABILITY[2]
SINGLE, NO DEPENDENTS	-.443 (.170)‾	-.059
OCS GRADUATE	-.118 (.320)	-.013
ROTC GRADUATE	-.420 (.265)	-.053
ENLISTED SERVICE (GREATER THAN ONE YEAR)	-.168 (.191)	-.021
HIGHLY SELECTIVE COLLEGE	-.076 (.240)	-.009
MALE	-1.884 (.782)*	-.203
WHITE	.332 (.242)	.038
HIGH GPA (3.2-4.0)	.532 (.256)*	.062
HIGH TECHNICAL QUALIFICATION CODE	.817 (.281)‾	.099
HIGH MATH QUALIFICATION CODE	.300 (.257)	.037
TECHNICAL UNDERGRADUATE MAJOR	-.079 (.183)	-.006
MORE THAN TWO SEA TOURS	-.109 (.155)	-.009
ENGINEERING OFFICER OF THE WATCH	.721 (.157)‾	.089
SWO DEPARTMENT HEAD SCHOOL GRADUATE	1.510 (.156)‾	.283
TACTICAL ACTION OFFICER	.866 (.196)‾	.084
COMBAT SYSTEMS OFFICER	.946 (.411)*	.071
OPERATIONS OFFICER (NTDS)	1.823 (.599)‾	.105
AGE AT COMMISSIONING	-.138 (.033)‾	-.020
EARLY PROFESSIONAL QUALIFICATIONS	.333 (.147)*	.044
INTERCEPT	4.71 (1.146)	--
CHI-SQUARE (LIKELIHOOD RATIO TEST)	357.825	
CONCORDANCE RATIO[3]	.811	
SAMPLE SIZE	1,588	

[1] STANDARD ERROR IN PARENTHESES.
[2] FROM ORDINARY LEAST SQUARES ESTIMATION.
[3] IS A MEASURE OF THE PREDICTIVE ABILITY OF THE MODEL.
* SIGNIFICANT AT THE .05 LEVEL.
‾ SIGNIFICANT AT THE .01 LEVEL.

The results of the pooled model empirically support hypotheses held concerning the positive effects of qualifications on competitiveness for promotion. The significance of the early professional qualifications variable has implications for future force downsizing in that it provides a MOE at the three years of service career point that is positively significant in predicting selection to the career force.

Table X displays the results of the separate logit equations for the promotion to O-4 by college selectivity. Across all three selectivity categories, graduation from department head school was significant and positive in predicting promotion. ROTC commissioning source is significant and negative only within the highly selective category. Both the highly selective and medium selective categories show significant positive effects from early qualifications. Only in the medium selective category is the department head billet type significant. In the less selective category, only graduation from department head school was positively significant in predicting promotion.

Table X. LOGIT ESTIMATES OF THE PROMOTION MODEL BY COLLEGE SELECTIVITY[1]

	COLLEGE SELECTIVITY		
INDEPENDENT VARIABLES	HIGH	MEDIUM	LESS
SINGLE, NO DEPENDENTS	-.051 (.279)	-.857 (.255)**	-.126 (.532)
OCS GRADUATE	.379 (.529)	[2]	[2]
ROTC GRADUATE	-.611 (.304)*	-.078 (.331)	-.374 (.539)
ENLISTED (> ONE YEAR)	-.449 (.430)	.045 (.270)	-.201 (.405)
MALE	-1.35 (1.234)	-1.793 (1.137)	[3]
WHITE	.497 (.370)	-.157 (.458)	.346 (.515)
HIGH GPA (3.2-4.0)	1.182 (.494)*	.559 (.422)	.120 (.539)
HIGH TQC	.648 (.375)**	.945 (.546)**	.407 (.947)
HIGH MQC	.557 (.360)	-.273 (.442)	.196 (.908)
TECHNICAL MAJOR	-.195 (.260)	-.033 (.317)	.508 (.659)
MORE THAN TWO SEA TOURS	-.514 (.274)**	.180 (.230)	-.170 (.385)
EOOW	.796 (.280)**	.815 (.237)**	.300 (.365)
DEPARTMENT HEAD SCHOOL	2.091 (.280)**	1.240 (.235)**	1.840 (.407)**
TACTICAL ACTION OFFICER	.771 (.336)*	1.006 (.314)**	.448 (.428)
COMBAT SYSTEMS OFFICER	.831 (.635)	.808 (.635)	[3]
OPERATIONS OFFICER (NTDS)	[3]	1.452 (.752)**	.962 (1.082)
AGE AT COMMISSIONING	-.054 (.120)	-.148 (.045)**	-.150 (.065)*
EARLY QUALIFICATIONS	.308 (.251)	.570 (.226)*	.070 (.355)
INTERCEPT	1.960 (3.040)	5.051 (1.655)	3.146 (1.794)
CHI-SQUARE (LIKELIHOOD RATIO TEST)	149.372	167.695	61.523
CONCORDANCE RATIO[4]	.830	.815	.813
SAMPLE SIZE	639	674	239

[1] STANDARD ERROR IN PARENTHESES.
[2] MODEL BASE CASE CONDITION.
[3] CELL SIZE TOO SMALL TO ESTIMATE.
[4] IS A MEASURE OF THE PREDICTIVE ABILITY OF THE MODEL.
* SIGNIFICANT AT THE .05 LEVEL.
** SIGNIFICANT AT THE .01 LEVEL.

Viewing the log likelihood ratio tests and concordance ratios it can be seen that the models for high and medium selective categories have the highest predictive ability. The log likelihood chi-square for the less selective category is only a third of the magnitude of the other two models. Because of the reduced size of the promotion model sample size versus the O-3 selection board group, some of the cells cannot be accurately predicted.

Through discussion of the bivariate and multivariate analysis, improved methodologies have been demonstrated for studying officer measures of effectiveness. As seen in this chapter, the richness of the data set and the adaptability of the models support many more variations of the three basic logit equations. Across the three models and as seen in the interrelationship between the early qualification and promotion models was the importance and contribution of the human capital investments in undergraduate education and training.

Although the scope of this preliminary research effort was limited to investigating and testing a new data set with improved methodologies, the results do contribute to ongoing policy discussions. Chapter V summarizes this study and introduces policy recommendations related to this area of research.

V. SUMMARY AND RECOMMENDATIONS

This chapter summarizes the conclusions that may be drawn from the results of this thesis. It also proposes recommendations and associated policy implications.

A. SUMMARY

As seen by the statistical significance of the various background factors in the three models developed in this research, it can be concluded that background factors are important in explaining MOE attainment. In the basic MOE models for retention, promotion, and early professional qualifications, MOE attainment reflected differences in:

- commissioning source,
- college selectivity,
- navy experience, and
- navy training.

These background factor categories represent differences in human capital investments made by the individual and by the Navy. In all of the models, with the exception of retention, increased levels of human capital investment, as measured by:

- department head school attendance,
- qualifications resulting from on-the-job training (engineering officer of the watch and officer of the deck (underway)), and

- selective undergraduate colleges, having greater likelihood of higher educational quality and costs,

are positively correlated with increased levels of MOE attainment.

Viewing the SWO career path from the beginning of the undergraduate education or accession training through the career point of the defined MOE, it is now understood that changes to human capital investments associated with this career path will impact individual MOE attainment differently. In considering the future impact of budget reductions in the area of Navy training, the impact on MOE attainment may be felt by graduates of the medium and less selective colleges, since training investments are statistically important for those groups in explaining their MOE attainment.

B. RECOMMENDATIONS

This study provides a preliminary analysis of performance differences needed to measure the benefits of Navy human capital investments. In order to quantitatively determine the optimal accession source mix, a cost-benefit analysis study needs to be completed. In such a study, the cost calculations should not be limited to the average costs associated with the undergraduate or commissioning program on the day of commissioning, but rather should include all costs from the first day of the pre-commissioning program to the career point of the MOE attainment. Only then, would the true

organizational cost of the MOE attainment be determined and quantified for subsequent decision analysis.

The differences in MOE attainment, when analyzed by commissioning source and college selectivity, demonstrate the need for further study in order to control the tremendous variations in this era of downsizing. During the expansion of the Navy in the 1980s, officer end strength goals reflected an emphasis on meeting quantity criteria. The contraction of the naval officer end strength in the 1990s has invented the term "shaping" to describe meeting the quality and specialty requirements for the Navy's future structure. For this "shaping" to be effective, the right mix of officer candidates must be accessed so that a quality base population exists and is grown from within rather that later "shaped" in an inefficient and costly process.

The Total Quality Leadership (TQL) program within the Navy organization contains all the ingredients for establishing the framework for accessing or manufacturing quality officers. In this downsizing era, rather than focusing on meeting minimum standards with an eye towards quantity, the focus should be on accessing quality. The variations in officer performance during the growth years of the 1980s provides the analytical basis for applying aspects of TQL into the personnel policy process. The next logical step would be for officer community managers to first determine and then relate MOE attainment,

which can be viewed as long-term output, to the organizationally-defined process.

This study has highlighted the importance of background factors in conducting manpower, personnel, and training analysis. In particular, the usage of early professional qualifications from the Officer Master File contributed new research methodologies, which could be applied across all officer communities, limited only by the information available within existing databases. The methodology of incorporating qualifications as recorded by the awarding of additional qualification designator (AQD) codes has implications for current officer community management.

A stochastic manpower flow simulation model, COSMOS, was developed by the Center For Naval Analysis (CNA) to assist Bureau of Naval Personnel (BUPERS) SWO community managers in planning personnel flows. Presently, COSMOS reflects an individual's billet attainment based on time in a particular billet and where, career-wise, those individuals are located at a point in time. (Taylor, 1992) Only incorporating billet history does not provide the community managers with the requisite information for determining the quality of the individuals who are in those billets. Since COSMOS data are derived from the Navy Officer Master File, incorporating an individual's qualifications, as represented by AQDs awarded for such qualifications as command qualifications, engineering

officer of the watch, or tactical action officer, would provide a true quality status of the SWO community.

In summary, this study modeled three measures of effectiveness: retention, promotion, and early professional qualifications. Additional measures of effectiveness may contribute towards better quantifying the performance of officers based upon commissioning source and other associated human capital investments. In particular, incorporating officer fitness report information from data bases maintained by NPRDC would contribute an important intermediate MOE, which could then be used to predict success at subsequent statutory and administrative selection boards. Additional measures of effectiveness could be determined through gathering data at the career points of administrative screening boards in a similar fashion as was done in this study at the O-3 and O-4 selection board points. The SWO department head screening boards would provide an MOE prior to the O-4 selection board, while the executive officer (afloat) screening board would provide another MOE in the years immediately following the O-4 selection board.

Lastly, this study utilized data bases that provide career snapshots of an individual officer at the O-3 (2.5 to 3 years of service) and O-4 (8 to 10 years of service) selection boards. In order to determine the effect of various personnel policies, a longitudinal analysis of cohort groups should be the goal of future research.

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