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Analysis of the survival patterns of United States naval officers

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THESIS

ANALYSIS OF THE SURVIVAL PATTERNS OF UNITED STATES NAVAL OFFICERS

by

Ibrahim Korkmaz

March 2005

Thesis Co-Advisors: Stephen Mehay
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13. ABSTRACT

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The results of the survival analysis indicate that commissioning source has significant strong effect on survival rates with Naval Academy graduates have a better survival rate than other commissioning sources. Also, the analysis show that females and African-Americans have better survival rates than males and whites, respectively, and prior enlisted, older, graduates from non-selective colleges have higher survival rates than their counterparts. Additionally, Surface Warfare, Fleet Support and Supply Corps officers were found to have lower survival rates than officers in other communities. When survival functions for involuntary and voluntary separations were analyzed separately, the results were found different. Commissioning age, being African-American, single with children, commissioned from NROTC Contract Program, commissioned from OTHERSOURCE, being prior enlisted, having high GPAs and designated in AIR community had significant, negative effects on involuntary separations and significant positive effects on voluntary separations.

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ANALYSIS OF THE SURVIVAL PATTERNS OF UNITED STATES NAVAL OFFICERS

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ABBREVIATIONS AND ACRONYMS

ACCP	Aviation Career Continuation Pay
ACNP	Assistant Chief of Naval Personnel
AEDO	Aviation Engineering Duty Officer
AICP	Aviation Incentive Pay
AMDO	Aviation Maintenance Duty Officer
AOCS	Aviation Officer Candidate School
AQD	Additional Qualification Designation
AVF	All Volunteer Force
BUMED	Bureau of Medicine
CAPT	Captain
CDR	Commander
CDO	Command Duty Officer
CEC	Civil Engineering Corps
CNO	Chief of Naval Operations
CNP	Chief of Naval Personnel
CNRC	Commander Navy Recruiting Command
CWO	Chief Warrant Officer
DESG	Designator
DH	Department Head
DOD	Department of Defense
DOPMA	Defense Officer Personnel Management Act
EDO	Engineering Duty Officer
EMPRS	Electronic Military Personnel Records System
ENS	Ensign
FITREP	Fitness Report
FOS	Failure of Selection
FSO	Fleet Support Officer
FTS	Full Time Support
FY	Fiscal Year
GR	Grade
GURL	General Unrestricted Line
HR	Human Resource

IP	Information Professional
IRAD	Involuntary Release from Active Duty
JAG	Judge Advocate General
LCDR	Lieutenant Commander
LDO	Limited Duty Officer
LOS	Length of Service
LT	Lieutenant
LTjg	Lieutenant Junior Grade
LT&R	Lateral Transfer & Redesignation
MAT	Minimal Activity Tour
MILSPERMAN	Military Personnel Manual
MSC	Medical Service Corps
MSR	Minimum Service Requirement
NAVADMIN	Navy Administrative Message
NAVMAC	Navy Manpower Analysis Center
NAVPERS	Naval Personnel
NFO	Naval Flight Officer
NPQ	Not Physically Qualified
NROTC	Naval Reserve Officer Training Corps
OC	Officer Candidate
OCM	Officer Community Manger
OCS	Officer Candidate School
OMF	Officer Master File
OPA	Officer Program Authorization
OSD	Office of Secretary of Defense
OSR	Officer Summary Record
PAO	Public Affairs Officer
POC	Point of Contact
PSR	Performance Summary Record
RL	Restricted Line
SECNAVINST	Secretary of the Navy Instruction
SDO	Special Duty Officer
SSB	Special Separation Bonus
SSIP	Submarine Support Incentive Pay
STA	Seaman to Admiral
SUB	Submarine
SWO	Surface Warfare Officer

SWOCP	Surface Warfare Officer Continuation Pay
SWOCSB	Surface Warfare Officer Status Bonus Pay
SWOS	Surface Officer Warfare School
TA	Tuition Assistance
TAR	Training and Administration of Reserve
TERA	Temporary Early Retirement Authority
URL	Unrestricted Line
USMC	United States Marine Corps
USN	United States Navy
USNA	United States Naval Academy
USNR	United States Naval Reserve
VSI	Voluntary Separation Incentives
WOBA	Without Board Action
YCS	Years of Commissioned Service
YG	Year Group
YOS	Years of Service

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I. INTRODUCTION

The goal of this thesis is to identify and quantitatively evaluate the factors, especially commissioning source, that affect the longevity of officers in the U.S. Navy. Data for officers commissioned from 1983 to 1990 are examined. The ultimate objective of the study is to provide policymakers with information that can be used in formulating policies to increase the longevity of the Naval officers' careers.

A. BACKGROUND

> Improving officer retention is critical to meeting manpower requirements and achieving steady-state force structure. Under-accession and over-attrition of junior officer year groups throughout the drawdown, coupled with significant changes in the post-drawdown force structure, mandate officer retention levels significantly above the historical norm. We must continue improving retention to meet officer manning requirements, particularly among the Unrestricted Line communities; i.e., aviation, submarine, surface and special warfare.
>
> --Statement of Vice Admiral N. R. Ryan, Jr., U.S. Navy Chief of Naval Personnel and Deputy Chief of Naval Operations (Manpower & Personnel) 18 July 2001[1]

Throughout history, officers have become the backbone and a key component of the armed forces in all nations. The overall quality of a nation's military is highly correlated with the quality of its officers. Every military wants to recruit and retain the best individuals for its officer corps. Attracting and keeping high-quality personnel has been a challenge for the Armed Forces throughout history. Several trends have affected the U.S. officer recruitment process in recent years.[2]

1. Military Trends

- Improvements in the technology of military equipment have increased the need for user personnel with higher educational background levels.
- After the Cold War, the drawdown in the U.S. military caused a reduction in the numbers of officers in all four armed services.

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1 http://www.house.gov/hasc/openingstatementsandpressreleases/107thcongress/01-07-13ryan html, 14 January 2004 House Armed Services Committee, (Accessed February 22, 2005).

2 Bill Taylor, *Professional Military Education: An Asset for Peace and Progress: A Report of the CSIS Study Group on Professional Military Education*, (Washington, D.C.: Center for Strategic and International Studies, March 1997).

- Also, reductions in the defense budget have made it more difficult to attract and retain high quality officers.

2. Civilian Trends

- The popularity of the Armed forces with the public may affect recruiting success.
- Low unemployment and high wages in the private sector are a threat to military recruiting.
- The competition for high quality personnel between the private sector and the military affects recruiting.

The officer corps of the U.S. Navy is a mix of different officer commissioning sources such as the U.S. Navy Academy (USNA), Navy Reserve Officer Training Corps (NROTC), Officer Candidate Schools (OCS), Direct Appointments, and enlisted-to-officer Commissioning Programs. Each of these commissioning sources has strengths and weaknesses. For example, the Naval Academy provides a steady and reliable flow of highly trained officers to the Navy, but these officers cost more than officers from other commissioning sources because of long and intensive training. NROTC programs are less costly than USNA but they lack the quality of military training of USNA. A comparison of commissioning sources may be beneficial to an understanding of which commissioning source is the most effective for obtaining and retaining officers. Low turnover among high-quality personnel is one of the main concerns of the Navy, in order to reduce recruiting and training costs. If one of the commissioning sources has more positive effects on the longevity of officers, then the Navy may increase the accession of officers from this commissioning source. This study focuses specifically on the effects of the various commissioning sources on the longevity of officers.

B. OBJECTIVE AND RESEARCH QUESTIONS

This thesis evaluates the effect of officer accession programs on the longevity of the U.S. Naval officers' careers. The purpose of this research is to examine the factors that influence the survival of U.S. Naval Officers and the objective of this study is to help policymakers understand the effects of alternative commissioning programs on the longevity of Naval Officers' careers. The primary goal is to explain the effect of commissioning programs on the survival of Naval Officers. To reach this goal, a survival analysis is conducted on the survival patterns of officers who entered the service between the years 1983-1990.

1. Primary Questions

- What are the factors that influence Naval Officers' career longevity?
- Are there significant differences between commissioning sources in the survival of Naval officers who entered via each program?

2. Secondary Questions

- Are there any other critical effects, for example having a technical degree, on the survival of the officers?
- Are there significant differences in survival patterns between Community Designators?
- Are there differences between the results of this study and prior studies?

C. SCOPE AND METHODOLOGY

This thesis examines the careers of United States Navy officers with respect to their completed commissioned service time in months by analyzing officer cohorts from 1983 to 1990. To accomplish this, the literature about civilian and military turnover and retention is reviewed. Following this review, the personal demographics and characteristics of Naval officers are examined. Then, survival analysis methods are developed and these methods are applied to the data set of Naval officers from year groups 1983 to 1990. Finally, conclusions and recommendations are provided.

D. ORGANIZATION OF STUDY

This study is organized into six chapters. Chapter II describes the United States Navy Officer personnel system and the career development of U.S. Navy officers. The first part of the chapter gives information about the structure of the personnel system and the commissioning sources. The second part is about Naval officer career development in the Navy after commissioning. Chapter III reviews the literature on civilian and military turnover to provide a background for developing a theoretical model to analyze the factors that influence Navy officers' decisions to stay or leave the Navy. Chapter IV discusses the methodology and data used to analyze the effect of commissioning source on officer longevity. The first part of the chapter is a brief description of the survival analysis methodology, including basic concepts such as censoring, the nature of survival data, the survival function, the hazard function, common ways of representing the probability distribution of event times, and background information needed to understand survival analysis methods. The second part of the chapter describes the SAS software

procedures for survival analysis used in this thesis. The LIFETEST, LIFEREG and PHREG procedures are explained and the strengths and weaknesses of each procedure are discussed. The third part discusses the specifics and limitations of data, variable descriptions, and model specification. Chapter V analyzes the data described in previous chapters and presents the results of survival analysis. The chapter is divided into four parts, the first three for each of the survival procedures, LIFETEST, LIFEREG, and PHREG and the fourth for voluntary and involuntary separations. Chapter VI summarizes the conclusions and recommendations based upon the statistical analysis. Areas of further research are also included in this final chapter.

II. UNITED STATES NAVAL OFFICER COMMISSIONING SOURCES AND CAREERS

A. OVERVIEW

This chapter describes the United States Navy Officer personnel system and the career development of U.S. Navy officers. The first part of the chapter gives information about the structure and the commissioning sources. Accession programs are critical to the career development of the officers since they impact their skills and aptitude of them. The second part is about the Naval officer career development in the Navy after commissioning.

Before World War I, the officer corps of the U.S. Military was very small, mostly raised from citizens as needed. After WWI, this began to change to cope with future threats. Until the 1950's, the draft system supplied the manpower requirements for the U.S. military. During WWII, the military officer corps continued to enlarge and reached its peak with the Soviet threat. After the Vietnam War, an all-volunteer system took the place of conscription. Large numbers of officers remained in peacetime.[3]

Today, officers comprise approximately 15% of the manpower of the U.S. Armed Forces. The remaining 85% are warrant officers and enlisted personnel.[4] The five major commissioning sources for most of the officers are the service academies, Reserve Officer Training Corps (ROTC) programs at public or private civilian institutions, Officer Candidate or Training School (OCS/OTS), direct appointment or through enlisted sources. The application procedures, age, experience, level of education, benefits, active-duty service obligation, and career field service opportunities differ for each program.

Differences between costs and quality of officer commissioning programs are very important for policy makers and the DoD for meeting officer requirements. Each of the commissioning sources has advantages and disadvantages. For example, the service

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[3] Bill Taylor, *Professional Military Education: An Asset for Peace and Progress: A Report of the CSIS Study Group on Professional Military Education*, (Washington, D.C.: Center for Strategic and International Studies, March 1997), 15.

[4] Michael R. Thirtle*, Educational Benefits and Officer-Commissioning Opportunities Available to U.S. Military Service Members*, (Santa Monica, CA: The Rand Corporation, 2001), 8, http://www.rand.org/publications/MR/MR981/index.html - 7.1KB.(Accessed January 7, 2005).

academies are considered more costly than other programs. However, historically they have been the sources for reliable high quality officers with military training in leadership and specific military subjects. ROTC programs are less costly than service academies but they provide less military training. OCS Schools are also less costly and very flexible sources but they have the same disadvantage as ROTC, that of limited military training time.[5]

In Table 1, note the percentage distribution of the Source of Commission of Active Component Officer Accessions and Active Component Officer Corps in the Navy for FY 2002.

Table 1. FY 2002 Source of Commission of Active Component Navy Officer Accessions and Officer Corps (%). (From: Population Representation in the Military Services , Office of the Under Secretary of Defense, Personnel and Readiness, Fiscal Year 2002, Table 4.3 http://www.humrro.org/poprep2002/chapter4/c4_commission.htm (Accessed December 5, 2004))

Source of Commission	Navy
ACTIVE COMPONENT OFFICER ACCESSIONS	
Academy	17.1
ROTC-Scholarship	16.7
ROTC-No Scholarship	1.6
OCS/OTS	25.1
Direct Appointment	20.6
Other*	18.3
Unknown	0.5
Total	100
ACTIVE COMPONENT OFFICER CORPS	
Academy	19.2
ROTC-Scholarship	18.2
ROTC-No Scholarship	2.2
OCS/OTS	22.2
Direct Appointment	21
Other*	17.3
Unknown	0
Total	100

Columns may not add to total due to rounding.

*Includes officers trained in one Service and accessed into another (primarily Marine Corps).

[5] Marvin M. Smith, "*Officer Commissioning Programs*," *Defense Economics*, Vol. 2 (1991), 313.

B. NAVAL OFFICER COMMISSIONING PROGRAMS

An officer's commission is an appointment by the President of the United States. This can be seen as a contract between the individual and the country to perform military duties. There are two types of commission: regular commission and reserve commission.

A regular commission requires the individual to serve in the military full-time. A reserve commission may be full time or part-time. Every officer graduated from the commissioning sources receives a reserve commission. With the passage of the new law in September 30, 1996, an officer can only earn a regular commission after completing at least one year of active-duty service.[6]

As stated before, every individual who wants to be an officer in the U.S. Navy must consider one of the five commissioning sources, which are:

1. Naval Academy
2. The Reserve Officer Training Corps (ROTC)
3. Officer Candidate School (OCS)
4. Direct appointment
5. Through Enlisted Corps

Today, regardless of the commissioning source, the main qualification to be an officer is a college degree. Complex technologies require most officers to have a strong background in science and engineering concepts. Figure 1 summarizes the typical methods of becoming an officer in the military. This figure shows the different choices available to individuals. Background and personal characteristics influence the decision of individuals on the path to commissioning. The following sections describe each commissioning source, including mission, training period and history.

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[6] Michael R. Thirtle, *Educational Benefits and Officer-Commissioning Opportunities Available to U.S. Military Service Members*, (Santa Monica, CA: The Rand Corporation, 2001), 11, http://www.rand.org/publications/MR/MR981/index.html - 7.1KB. (Accessed January 7, 2005).

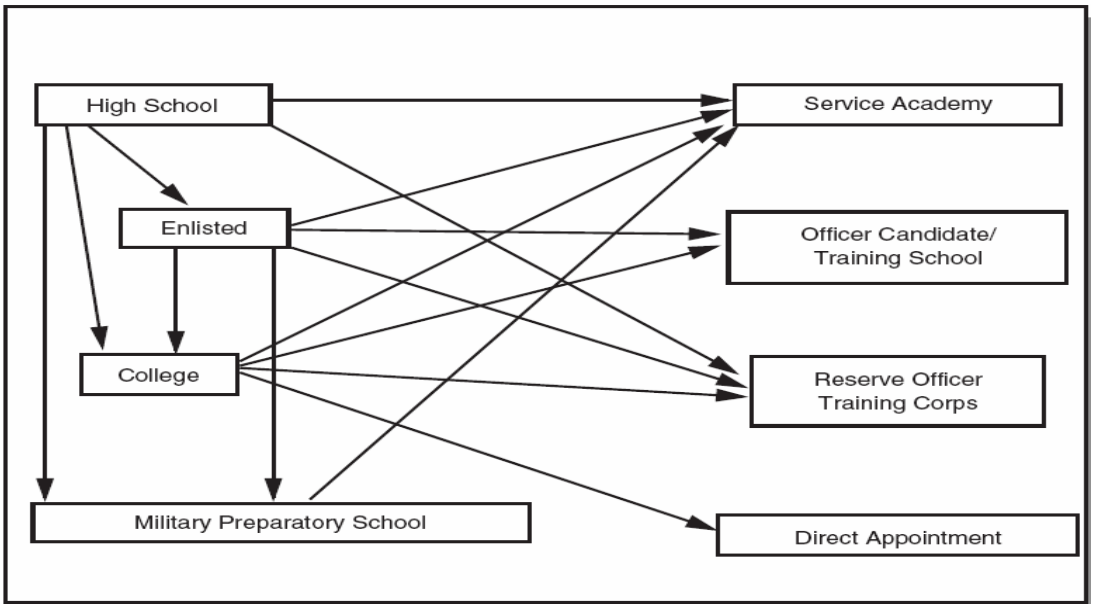

Figure 1. Typical Methods of Becoming an Officer in the Military. (From: Michael R. Thirtle, Educational Benefits and Officer-Commissioning Opportunities Available to U.S. Military Service Members, Santa Monica, California: The Rand Corporation, 2001), 11, Figure 3.2, p. 13).

1. Naval Academy

Through the efforts of the Secretary of the Navy George Bancroft, the Naval Academy was founded in 1845, in Annapolis, Maryland with a class of 50 midshipmen[7] and seven professors. The academic plan was four years of academic education with training aboard ships each summer. After this time, the Naval Academy grew with the expanding need for military officers. In 1933, Congress authorized the awarding of Bachelors of Science degrees by the Naval Academy.[8]

The mission of the U.S. Naval academy is:

> To develop midshipmen morally, mentally and physically and to imbue them with the highest ideals of duty, honor and loyalty in order to provide graduates who are dedicated to a career of naval service and have potential for future development in mind and character to assume the highest responsibilities of command, citizenship and government.[9]

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[7] All Naval Academy students, men and women, are called midshipmen, which is a rank between chief warrant officer and ensign in the Navy.

[8] The U.S. Naval Academy Webpage, "*A Brief History of the U.S. Naval Academy*," http://www.usna.edu/VirtualTour/150years/, (Accessed December 11, 2004).

[9] The U.S. Naval Academy Webpage, "*The United States Naval Academy Catalog*," http://www.usna.edu/Catalog/1introduction.pdf, (Accessed December 16, 2004).

The Naval Academy gives an intensive four years of academic and professional training to the midshipmen to make them into highly qualified naval and marine officers. Character Development, Engineering and Weapons, Mathematics and Science, Humanities and Social Sciences, Information Technology Services, and Professional Development are five main divisions of the curriculum. Midshipmen may choose to study one of the 18 different major fields within these five divisions.[10] In particular, the engineering programs of the USNA rank among the top colleges in the United States. Below are the divisions and departments in the USNA.[11]

Divisions & Departments:

- Division of Character Development
- Division of Engineering and Weapons
  - Aerospace Engineering
  - Electrical Engineering
  - Mechanical Engineering
  - Naval Architecture and Ocean Engineering
  - Weapons and Systems Engineering
- Division of Humanities & Social Sciences
  - Economics
  - English
  - History
  - Language Studies
  - Political Science
- Division of Information Technology Services
- Division of Mathematics and Science
  - Chemistry
  - Computer Science
  - Mathematics

[10] The U.S. Naval Academy Webpage, "*Academics*," http://www.nadn.navy.mil/academics.htm, (Accessed December 16, 2004).

[11] The U.S. Naval Academy Webpage, "*The United States Naval Academy Catalog*," http://www.usna.edu/Catalog/1introduction.pdf, (Accessed December 16, 2004).

- Oceanography
- Physics

- Division of Professional Development
  - Leadership, Ethics, and Law
  - Professional Programs
  - Seamanship and Navigation

USNA is open to all civilian high school graduates and enlisted members of the U.S. Navy and the Marine Corps. Each year more than 10,000 applicants apply for admissions. The number accepted is generally about 1,200. USNA is highly selective. An Admissions Board evaluates applicants' academic records, medical and dental health, physical fitness, leadership potential and motivation to be an officer. All candidates have equal opportunity but minority groups generally make up 20 % and women 15-17 % of those accepted.[12]

To be eligible to apply to the U.S. Naval Academy a candidate must be[13]:

- between 17-23 years of age;
- unmarried, not pregnant and with no obligations of parenthood;
- a United States Citizen (except for the limited numbers of international midshipmen specially authorized by Congress); and
- have excellent moral character.

Besides these qualifications, an applicant must be scholastically and medically qualified, pass the Naval Academy's Physical Aptitude Examination or similar test and receive an official nomination. Each applicant must receive an official nomination from one of several different sources during the admission process, U.S. senators, Members of the House of Representatives, the delegate to Congress from the District of Columbia, the resident commissioner of Puerto Rico, The governor of Puerto Rico, the resident

[12] The U.S. Naval Academy Webpage, "*The United States Naval Academy Catalog*," http://www.usna.edu/Catalog/1introduction.pdf, (Accessed December 16, 2004).

[13] The U.S. Bureau of Naval Personnel BUPERS-CD Webpage, "*MILPERSMAN 1531-010 Naval Academy Program 22 August 2002*," http://buperscd.technology.navy.mil/bup_updt/upd_CD/BUPERS/MILPERS/MILPERSMAN%20%201531%20-%20NAVAL%20ACADEMY.PDF, (Accessed December 20, 2004).

representative from the Commonwealth of the Northern Marianas Islands, and the delegates to Congress from Guam, the Virgin Islands and American Samoa, and the President.[14]

During the four-year program at USNA, midshipmen receive an academic education and military training. The program begins with Plebe Summer, a seven-week period designed to turn civilians into midshipmen. At the end of each year, during summer time, midshipmen attend various training programs to increase their military and leadership skills. After graduation, graduates are generally deployed on ships, submarines, squadrons, with SEAL teams or with Marine units, leading other young men and women. The Marine Corps can select up to 16 2/3 % of the graduates of USNA.[15]

The minimum service obligation for the USNA graduates is five years on active duty and three years in the reserve forces. The service commitment begins at graduation, when the graduate is commissioned as an ensign in the Navy. All physically qualified graduates are commissioned into the Navy's Unrestricted Line. Physically unqualified graduates are generally commissioned into the Restricted Line or Staff Corps specialties such as Intelligence, Supply Corps or Civil Engineer Corps.[16]

2. The Reserve Officer Training Corps

The NROTC Program is the largest source of Navy and Marine Corps officers. It was established to educate and train individuals as commissioned officers for the Unrestricted Line Naval Reserve and Marine Reserve corps. Of the graduates, 16 2/3 % are commissioned in the Marine Corps.

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14 The U.S. Naval Academy Webpage, "*The United States Naval Academy Catalog*," http://www.usna.edu/Catalog/6careerops.pdf, (Accessed December 16, 2004).

15 William E. O'Brien, *The Effect of Marine Corps Enlisted Commissioning Programs on Officer Retention*, Master's Thesis, Naval Postgraduate School, Monterey, California, June 2002, 7.

16 The U.S. Naval Academy Webpage, "*The United States Naval Academy Catalog*," http://www.usna.edu/Catalog/6careerops.pdf, (Accessed December 16, 2004).

The mission of the NROTC program is:[17]

> …to train, evaluate, and screen officer candidates to ensure that they possess the moral, intellectual, and physical qualities for commissioning and the leadership potential to serve successfully as company grade officers in the operating forces.

The basic requirements for an applicant to the NROTC program are that he or she must:[18]

- Be a United States citizen
- Be 17-23 years old.
- Be a high school graduate.
- Be physically qualified.
- Have excellent moral character,
- Have no record of military or civilian offenses.
- Gain admission to a college that sponsors an NROTC unit.
- Have a minimum SAT test score of 530 verbal and 520 math or minimum ACT test score of 22 in both English and math.

The NROTC program was established in 1926 in only six universities: University of California at Berkeley, Georgia Institute of Technology, Northwestern University, University of Washington, and Harvard and Yale Universities. The Marine Corps entered into the program in 1932. Currently, the NROTC Program provides scholarship or non-scholarship options in 35 states at 71 colleges and universities in 149 host units.[19] Active duty enlisted sailors also can attend NROTC programs.

There are two types of NROTC programs. NROTC provides scholarship or non-scholarship options. Scholarships are not required to attend an NROTC program. Non-scholarship programs provide limited pay and uniform costs in the last two years of college. After graduation, if the students decide to accept a commission, they are obliged to serve in the Navy for eight years, of which three and a half years must be on active

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[17] The U.S. NROTC Webpage "*Program Mission*," https://www.nrotc.navy.mil/program_mission.cfm, (Accessed December 18, 2004).

[18] William E. O'Brien, *The Effect of Marine Corps Enlisted Commissioning Programs on Officer Retention*, Master's Thesis, Naval Postgraduate School, Monterey, California, June 2002, 7.

[19] The U.S. NROTC Webpage "*Colleges and Universities*," https://www.nrotc.navy.mil/colleges-univers.cfm, (Accessed December 18, 2004).

service.[20] Students in NROTC scholarship programs receive monthly pay, all educational fees, the cost of books and a uniform. The obligation time for these students after commissioning is the same, eight years, of which four years must be on active service.[21]

NROTC midshipmen are required to complete their courses at the colleges. Also, they are required to take several naval science courses on campus such as navigation, in addition to the college's courses. Navy midshipmen are required to take two semesters of calculus and two semesters of physics courses due to increasing technological complexity in the Navy.[22] Also, in the summer, midshipmen receive military training to be integrated into the Navy. After graduation, NROTC Scholarship Program and NROTC Non-Scholarship Program midshipmen are commissioned as Ensigns in the Naval Reserve or Second Lieutenants in the Marine Corps Reserve.

3. Officer Candidate Schools

Navy Officer Candidate School (OCS) brought flexibility to fill the gaps in the officer corps of the Navy. They are the most flexible of the commissioning sources. This feature allows the Navy to fill gaps in the officer corps easily to meet service needs. Also, they are the quickest way for civilians and non-commissioned officers to become officers.[23]

OCS grew out of the voluntary training camps for undergraduate students in World War I. Officer Candidate School is located at the Naval Aviation Schools Command in Pensacola, Florida. It is a precise course for new non-commissioned, unrestricted-line and restricted-line officer candidates. Over the course of 13 weeks, enlisted Sailors and civilians are transformed into Naval officers. OCS prepares a student for the roles and responsibilities expected of U.S. naval officers through academic and

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[20] The U.S. Bureau of Naval Personnel BUPERS-CD Webpage, "*MILPERSMAN 1533-010 Naval Reserve Officers Training Corps (NROTC) Scholarship Programs; 4-Year Scholarship Program1533-010*, http://buperscd.technology.navy.mil/bup_updt/upd_CD/BUPERS/MILPERS/MILPERSMAN%20%201533%20-%20RESERVE%20OFFICER%20TRAINING%20CORPS%20.PDF, (Accessed December 18, 2004).

[21] The U.S. NROTC Web Page, "*Frequently Asked Questions Concerning NROTC*," https://www.nrotc.navy.mil/faqs.cfm, (Accessed December 18, 2004).

[22] Ibid.

[23] Michael R. Thirtle, *Educational Benefits and Officer-Commissioning Opportunities Available to U.S. Military Service Members*, (Santa Monica, CA: The Rand Corporation, 2001), 15. http://www.rand.org/publications/MR/MR981/index.html - 7.1KB, (Accessed January 7, 2005).

military courses and physical fitness training. Course subjects include naval operations, orientation and administration, Navy history, strategic deterrence and sea control, shipboard management, combat systems, ship control and surface ship fundamentals.[24]

The 13 week course is very demanding, both physically and physiologically. The requirements for admission to the Navy OCS are:[25]

- Must be a U.S. citizen,
- Have good moral character,
- Under age 35 for all designators,
- Excellent health and physical fitness,
- A bachelor's degree from an accredited institution,
- Must take the Officer Aptitude Rating (OAR) examination.

About 90% of the candidates successfully complete the course. About 10% either leave the Navy or transfer to the Recruit Training Command Great Lakes for enlisted basic training. OCS commissions Naval Aviators, Naval Flight Officers Surface Warfare Officers, Submarine Warfare Officers, Special Operations Officers, Special Warfare Officers, Supply Corps Officers, Civil Engineer Corps Officers, Aerospace Maintenance Duty Officers, Intelligence Officers, Cryptology Officers, Public Affair Officers and Oceanographers.[26]

4. Direct Appointments

Direct appointments are mostly for individuals who have advanced degrees in medical, legal, and religious fields. They enter the Navy at higher ranks compared to the other commissioning sources. The entrance rank depends on civilian experience, educational background, professional field and the needs of the military.[27] These men and women provide the professional, scientific and technical skills required by a wide variety of occupations found at sea and ashore. Officers routinely supervise highly skilled staffs and are responsible for sophisticated equipment.

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[24] The U.S. Navy OCS Webpage, http://www.nsgreatlakes.navy.mil/otcp/, (Accessed December 14, 2004).

[25] Ibid.

[26] Ibid.

[27] Michael R. Thirtle, *Educational Benefits and Officer-Commissioning Opportunities Available to U.S. Military Service Members*, (Santa Monica, CA: The Rand Corporation, 2001), 18, http://www.rand.org/publications/MR/MR981/index.html - 7.1KB. (Accessed January 7, 2005).

To be accepted into the Direct Appointment program:

- An applicant must be a United States citizen of good moral character.
- Must not have reached 35 years of age at time of commissioning and commencing extended active duty in the October following application for commission.
- Must meet the physical requirements for appointment.
- At the time of appointment, an applicant must be a graduate of an accredited institution.

Direct appointments are required to attend a condensed training program, normally three to five weeks, which provides military orientation. After graduation, they are required to maintain their commission for eight years from the date of their principal appointment. This includes a four-year active duty obligation, which begins when the officer reports to his or her first duty station. Following the completion of their active duty obligation, officers may serve in an inactive status.[28]

5. Enlisted-to-Officer Commissioning Programs

Enlisted-to-Officer Commissioning Programs are ways for commissioning exceptional enlisted service members as officers in the U.S. Navy. In this way, selected individuals become ready to attend NROTC or OCS programs. Before NROTC or OCS, they must earn a college degree. Over the years, many different enlisted commissioning programs have been offered. To make it more understandable and easier to apply for any/all of them, the Navy recently combined most of them into a single program:[29] Seaman-To-Admiral-21 (STA-21). The STA-21 Commissioning Program is designed to meet the goals of the Navy in the 21st Century. The STA-21 is a full-time, undergraduate education program that provides an excellent opportunity for outstanding active duty enlisted personnel in the Navy or Naval Reserve who have previous college credit (less than a baccalaureate degree) to earn an officer commission. In this way, outstanding active duty Sailors can receive a college education and become commissioned officers in

[28] The U.S. Judge Advocate General's Corps Web Page, *"Direct Appointment,"* http://www.jag.navy.mil/html/direct_appointment.htm, (Accessed December 20, 2004).

[29] The U.S. Navy Seaman-to-Admiral-21 Program Web Page, "*Overview*," https://www.sta-21.navy.mil/overvw.html, (Accessed December 20, 2004).

the Unrestricted Line (URL), Special Duty Officer (Intelligence), Special Duty Officer (Cryptologist), Nurse Corps (NC), Supply Corps (SC), or Civil Engineer Corps (CEC).[30]

The following Enlisted-to-Officer Commissioning Programs are combined to form Seaman-To-Admiral-21:

- Seaman to Admiral
- Enlisted Commissioning Program (ECP)
- Aviation Enlisted Commissioning Program (AECP)
- Nuclear Enlisted Commissioning Program (NECP)
- Civil Engineer Corps Enlisted Commissioning Program (CECECP)
- Fleet Accession to Naval Reserve Officer Training Corps (NROTC)
- Broadened Opportunity for Officer Selection and Training (BOOST)

Before STA-21, some programs required the service member to pay for tuition and other education expenses, and some programs required the enlisted sailor to be away from active duty. During this program, they receive full active-duty pay and allowances. The STA-21 Program will keep all participants on active duty at their current enlisted pay grade. This means they will receive all the pay, allowances, benefits, and privileges they currently enjoy and will still be eligible for enlisted promotion while in the program. In addition, the sailors will receive up to $10,000 per year to cover tuition, books, and fees.[31]

To be eligible for STA-21 program, sailors must:[32]

- Be a citizen of the United States,
- Be recommended by their Commanding Officer,
- Have good moral character,
- Be serving on active duty in the U.S. Navy or Naval Reserve including Training and Administration of the Reserves (TAR), or Selected Reserves (SELRES), and Navy Reservists on active duty except for those on active for training (ACDUTRA) to include annual training (AT) and initial active duty for training (I-ACDUTRA).
- Be a high school graduate,

[30] The U.S. Navy Seaman-to-Admiral-21 Program Web Page, "*Overview*," https://www.sta-21.navy.mil/overvw.html, (Accessed December 20, 2004).

[31] Ibid.

[32] Ibid.

- Be able to complete requirements for a baccalaureate degree in 36 months or less,
- Be able to complete degree requirements and be commissioned prior to their 31st birthday,
- Maintain a cumulative Grade Point Average (GPA) of 2.5 or better on a 4.0 scale while enrolled in STA-21,
- Have a SAT or ACT test score,
- Meet physical commissioning standards,
- Have no record of certain court or disciplinary actions,
- Have passed a Personal Fitness Assessment (PFA),
- Individuals who have already obtained their baccalaureate degree are not eligible for STA-21 and should apply directly for Officer Candidate School (OCS).

STA-21 program graduates will incur a five to eight year active duty obligation according to the type of the service upon commissioning. After successfully earning a college degree and graduating from his or her respective university, the officer candidate will be commissioned an Ensign in the United States Naval Reserve. Following graduation from the university, newly commissioned Ensigns are sent to initial training for their officer community.[33]

After examining the commissioning sources, a close look to the career development and career paths will be helpful in understanding the effects of commissioning sources on the careers of Naval officers.

C. NAVAL OFFICER CAREER DEVELOPMENT

1. History

Before World War II, there were two departments for national defense: the Department of the Navy and the Department of the War. The officers in these departments were treated differently in terms of pay, promotion and benefits.[34] The Naval officers were initially paid only when they were on sea duty. Later, partial pay was paid for shore duty. The promotion system was based on seniority until the 1900's in the

[33] The U.S. Navy Seaman-to-Admiral-21 Program Web Page, "*Overview,*" https://www.sta-21.navy.mil/overvw.html, (Accessed December 20, 2004).

[34] Harry J. Thie, et al., *Aft and Fore: A Retrospective and Prospective Analysis of Navy Officer Management*, (Santa Monica, CA:RAND Corporation, 2003), 7, http://www.rand.org/publications/MR/MR1479/MR1479.ch2.pdf. (Accessed January 8, 2005).

Navy and up to World War II in the Army. The Navy implemented the up-or-out promotion system in 1916. Before that, an officer must only wait his turn to be promoted. Until the 1870's, the only way to leave the service was to die, to become disabled or to quit. The retirement system came in after the Civil War.

After 1947, Congress decided to make the systems in the Navy and the Army uniform, so the first military-wide personnel legislation, the Officer Personnel Act of 1947 (OPA) was signed by Congress. The evolution begun by OPA resulted in the Defense Officer Personnel Management Act of 1980 (DOPMA).[35] The OPA corrected many problems of officer career management arising from a transition from a small force to a huge wartime establishment in the 1940's. After World War II, the new threat of nuclear arms and the Cold War increased the need for highly mobile forces. Eventually, a new officer management system had to be developed which would lead to highly trained officers. At this time, the up-or-out system of the Navy was emphasized. The new policy established new standards. Officers were able to retire voluntarily after 20 years and mandatory retirement was adopted for the flag ranks after 30 years. More attention was paid to the retention of middle rank officers, mostly field grade officers, to controlling the number of officers above certain ranks, mostly major, and to standardizing changes among all the services.

In the early 1970's, officer management and officer requirements were affected by two major changes. First, the Total Force Policy set up the reserve forces as the primary augmentation for the active sources. This policy mandates the use of active, reserve, and civilian personnel in planning force structure, rather than using only active military personnel. Second, in 1973, with the coming of all-volunteer-force, the need for changes in the officer management legislation increased.[36]

In 1980, Congress enacted the DOPMA. The legislation brought new rules for officer career management and updated the constraints on the number of officers in the grades of O-4 to O-6 that each service might have as a percentage of its officer corps.

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[35] Harry J. Thie, et al., *Future Career Management Systems for U.S. Military Officers*, (Santa Monica, CA:RAND Corporation, 1994), 7, http://www.rand.org/publications/MR/MR868/MR868.ch1.pdf, (Accessed January 8, 2005).

[36] Ibid.

Also, DOPMA provided a single promotion system and tried to produce a stable system with fixed numbers of accessions, and stable retention and promotion rates. DOPMA provided that the number of officers allowed in each service in grades O-4 to O-6 is determined annually by the grade table, based on total officer end strength and also provided that all active-duty officers will become regular duty officers after 11 years in the service and they cannot be separated involuntarily unless they fail to promote. This increased the number in the officer corps. After the Cold War, the drawdown greatly affected the officer management system. High force reductions decreased the number in the officer corps to the lowest levels for decades.[37]

After giving historical and general information about the current officer career management system in the U.S. Navy, a close look at the officer career paths will be beneficial to understanding the many important points in a Navy Officer's career.

2. Naval Office Career Paths

The important factors in determining an officer's career path within the Navy are performance, requests for assignments, and advanced studies. The needs of the Navy come first in deciding duty assignments, but in addition, the Navy does consider personal preferences. Also, the current composition of the officer corps, and the professional development of each officer are important. The Navy officer corps is divided into three categories: unrestricted line (URL), restricted line (RL), and staff corps. URL officers are those considered eligible for command either at shore or at sea within one of the five areas of warfare expertise: surface, aviation, submarine, special operations, or special warfare. General URL officers are eligible only for command of shore activities. The RL officers are mostly specialized in engineering and maintenance duties. Officers specialized in areas such as civil engineering, law, supply, medicine, theology or nursing are the staff officers.

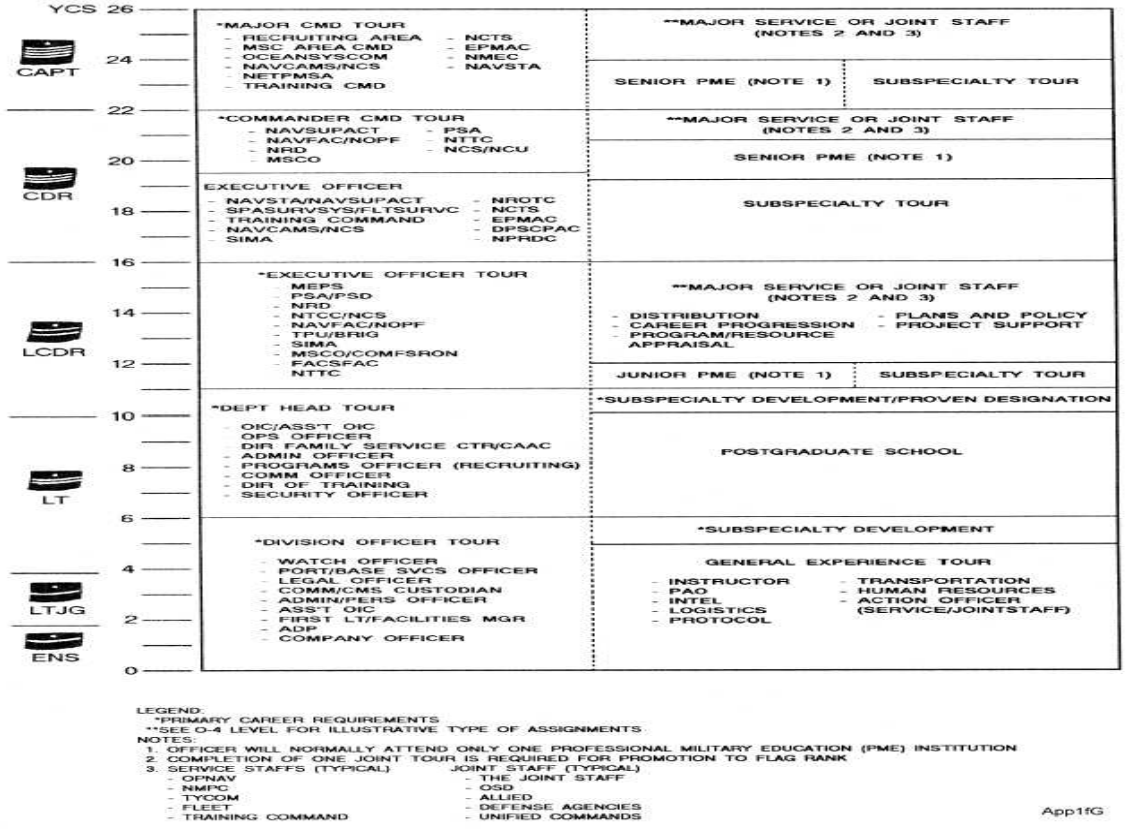
[37] Harry J. Thie, et al., *Future Career Management Systems for U.S. Military Officers*, (Santa Monica, CA:RAND Corporation, 1994), 7, http://www.rand.org/publications/MR/MR868/MR868.ch1.pdf, (Accessed January 8, 2005).

The Navy strongly encourages newly commissioned officers to select their career in one of the Unrestricted Line (URL) communities. In particular, physically qualified USNA and ROTC midshipmen must select their first three preferences from one of the URL warfare communities.[38]

a. Navy Unrestricted Line Officer Communities

The Unrestricted Line (URL) officers are those unrestricted as to type of duty assignments, and are eligible for command at sea and ashore. This is the most challenging and rewarding career option in the Navy. As mentioned before, in assigning officers, the Navy first considers the needs of the service. The current composition of the officer corps, professional development, choice and qualifications of the officers are the important factors in assigning officers.

Table 2. General URL Officer Career Path. (From: Navy Administration Training Manuals, Useful Information For Newly Commissioned Officers, NAVEDTRA 12967, November 1992, View A).



[38] University of Kansas – NROTC Web Page, "*Battalion Resources: Chapter 11*," http://www.ku.edu/~kunrotc/battalion_regs/chap_11.htm#1101, (Accessed December 25, 2004).

A Typical Unrestricted Line Officer professional career development pattern is shown in Table 2. In this table, note the general progression of assignments and promotions a typical URL officer can expect. Of course, no two officers will follow an identical career path, but on average, most of the officers will pass the same milestones in their careers. In this way, officers will have the experience, education and qualifications needed for future duties.

URL officers are assigned to one of five areas of warfare expertise: surface, aviation, submarine, special operations, or special warfare.

(1) Surface Warfare. The use of the Surface Fleet's ships in the missions of sea control, forward naval presence and projection of power ashore is the main duty of the Surface Warfare Community.[39] After commissioning, Surface Warfare Officers (SWOs) command sailors within various specialized divisions of a ship's crew. There are many homeports for the ships of the Surface Fleet in different places of the United States and the world. Also, the surface fleet has many different types of ships such as cruisers, destroyers, frigates, aircraft carriers, amphibious ships, minesweepers, patrol craft and auxiliary ships. Each of them contributes differently to the overall success of the Navy. Surface Warfare Officers must acquire in-depth of knowledge, especially in operations, combat systems or engineering and must learn the fundamentals of the others.

After arriving on their first ship, the newly commissioned SWOs probably will be assigned as division officers responsible for equipment and a division of approximately 10 personnel. During this job, every SWO has watch duties in the various parts of the ship. In this way, they can learn such subjects as navigational rules of the road, communications, ship handling, basic tactics, and weapons systems.[40] After earning the Officer of the Deck qualification, the officers are sent to the Surface Warfare Officers School in Newport, Rhode Island for a three week program. In this school, they increase their knowledge of Surface Warfare by participating in seminars, exercises, and simulators. After completing this program, they return to their same ships, complete SWO qualifications and earn Surface Warfare Officer Pins.

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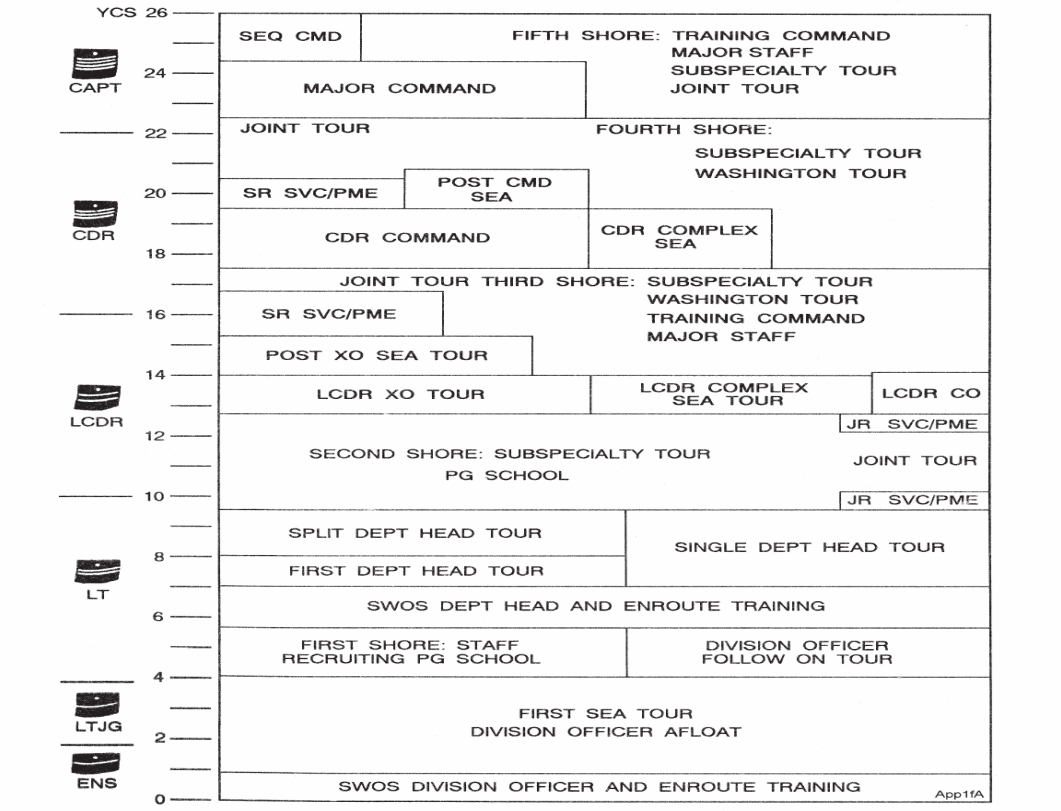
[39] The U.S. NROTC Web Page, "*Surface Warfare Officer*," https://www.nrotc.navy.mil/swofficer.cfm, (Accessed December 16, 2004).

[40] University of Florida NROTC Web Page, "*Careers*," http://nrotc.ufl.edu/content/main/careers.php, (Accessed December 19, 2004).

SWOs are assigned to two sea tours: a 27 month tour and an 18 month tour, for a total of 45 months, on two different ships. Between sea tours, they have shore tours, usually lasting approximately two years such as a staff job at the Pentagon or a Navy command, or serve as an instructor at SWOS, the Naval Academy, or a NROTC unit. A good performance record in the shore tour may bring a promotion and command of a ship's department to a SWO. This next sea tour lasts about 36 months. After this sea tour, the SWO will serve on a command's staff or at a military postgraduate school. The next shore tour might be as a ship's executive officer. After the next shore tour and a promotion, the goal of almost every SWO career would be the command of a ship.[41] The career path of Surface Warfare officers can be seen in Table 3.

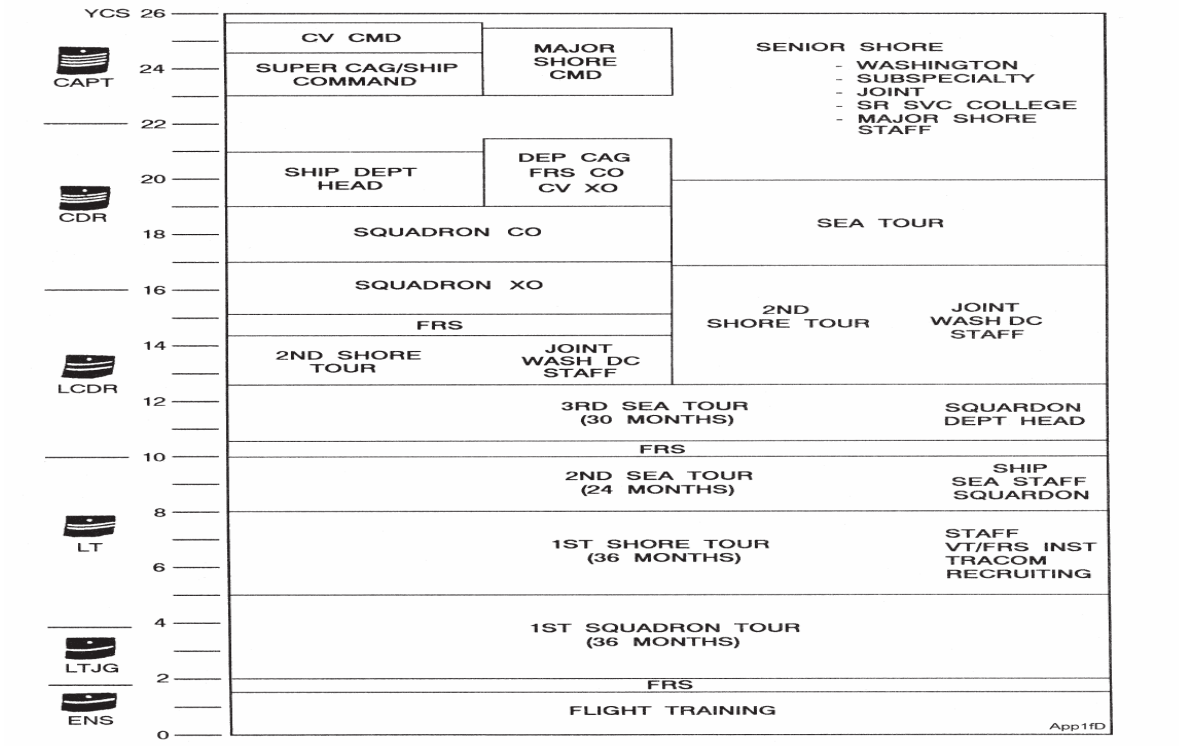
Table 3. Surface Warfare Officer Career Path. (From: Navy Administration Training Manuals, Useful Information For Newly Commissioned Officers, NAVEDTRA 12967, November 1992, View B).



[41] The U.S. NROTC Web Page, "*Surface Warfare Officer*," https://www.nrotc.navy.mil/swofficer.cfm, (Accessed December 19, 2004).

(2) Naval Aviation. The Aviation Warfare Community consists of Naval Flight Officers (NFOs) who are trained to fly Navy aircraft. NFOs begin their aviation career training at the Aviation Schools Command, Pensacola, Florida. The pilot candidates attend flight training for about 12 to 18 months. This course contains academic training in engineering, aerodynamics, air navigation, aviation physiology, and water survival, as well as physical applications of physiology and water survival training besides flight training. Intermediate or advanced level flight training is conducted at Pensacola or Randolf AFB, Texas. Before receiving the desirable "wings of gold" generally pilots or NFOs are assigned to a fleet.[42] Table 4 shows the career path of Navy Aviation officers.

Table 4. Navy Aviation Officer Career Path. (From: Navy Administration Training Manuals, Useful Information For Newly Commissioned Officers, NAVEDTRA 12967, November 1992, View C).



(3) Submarine. After being commissioned, Submarine officers attend a one year training program of which six months is classroom training at Nuclear

[42] University of Florida NROTC Web Page, *"Careers,"* http://nrotc.ufl.edu/content/main/careers.php, (Accessed January 5, 2005).

Power School in Charleston, South Carolina. The next six months, which is mostly practical training, is spent at one of Navy's two shore-based reactor training facilities in New York or Charleston, South Carolina. Next, they attend a 12 week Submarine Officer Basic Course in New London, Connecticut. In this course, they learn the theory and principles of submarine operation and control, the basics of submarine operations, fire, weapon and control systems and the responsibilities of a division officer. Some officers may attend the six week strategic weapons system course at either the Trident Training Facility in Kings Bay, Georgia or Bangor, Washington. After completing that course, they are assigned to a submarine.[43]

The first assignment of a submarine officer is usually as a division officer of a submarine. The division officers command a group of enlisted submariners. The first shore assignment is generally after three years of sea duty and lasts about two years. In this duty, they might attend a graduate program, hold a teaching job in a NROTC unit or work in group or squadron staffs.[44]

The second sea tour of a submarine officer is usually an assignment as a department head. He/she might be an Engineer Officer, Navigator/Operations Officer or Weapons Officer on a submarine. Before this tour, they must attend a 22 week Submarine Officer Advanced Course (SOAC) at the Naval Submarine School in New London, Connecticut. In this course, they receive in-depth training in the following areas: Shipboard Administration, Sonar, Electronic Warfare, Navigation, Weapons Systems, Weapons Employment Systems, Advanced Submarine Tactics and Weapons Employment, ASW and ASUW Operations, Communications and Operations, Leadership and Management Education Training. Attendance at SOAC requires an agreement to remain on active duty for 24 months after completion of the course.[45]

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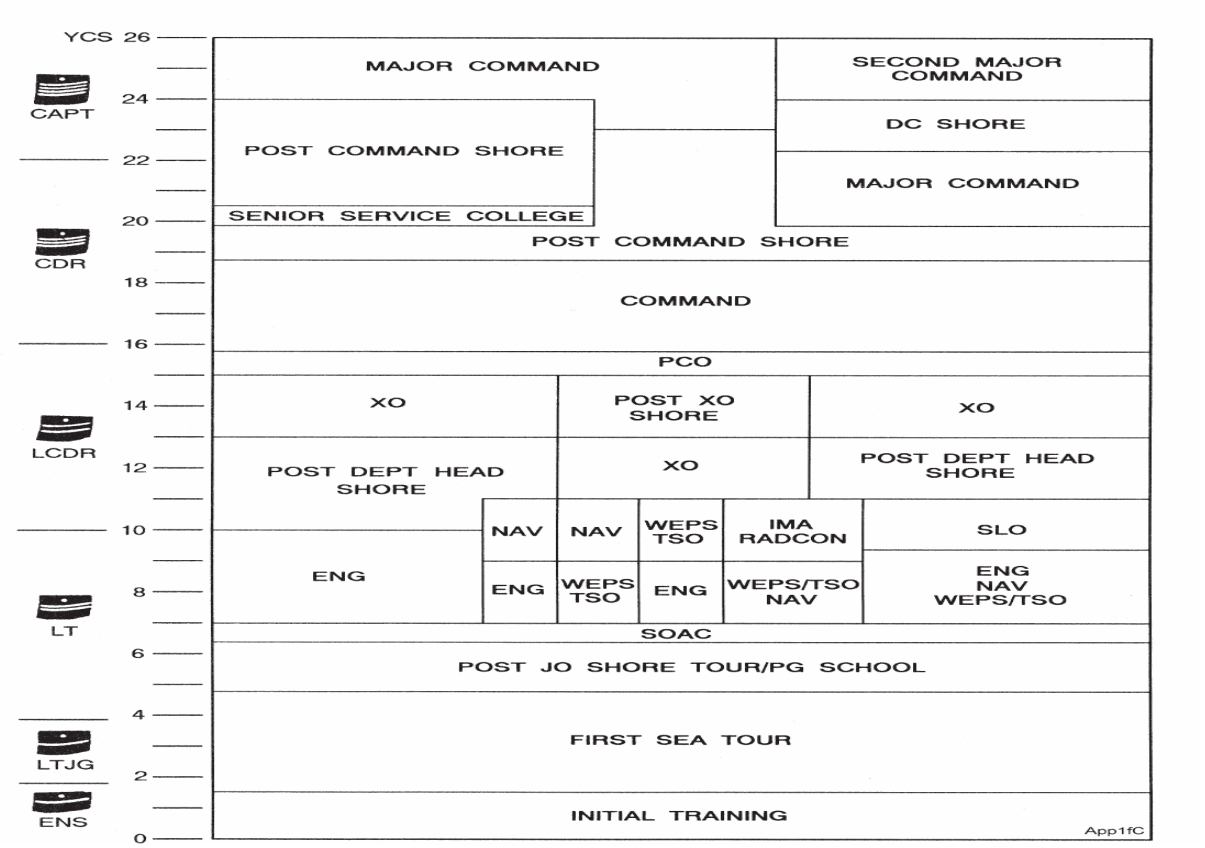
[43] University of Florida NROTC Web Page, *"Careers*," http://nrotc.ufl.edu/content/main/careers.php, (Accessed January 6, 2005).

[44] Ibid.

[45] The U.S. Naval Academy Webpage, "Submarines," http://www.usna.edu/Submarines/career.html, (Accessed January 6, 2005).

Most probably a two years duration shore duty assignment will follow a second sea tour. Many of the billets available are involved in the support of the Submarine Force on the staffs of the Squadron, Group and Type Commanders. After that, shore tour selected officers are assigned as Executive Officers on the submarines. Executive officer tour lengths are 22-26 months. After a two year shore tour, the next assignment could be the goal of almost every Submarine Officer, the command of submarine.[46] Table 5 shows the career path of Submarine officers.

Table 5. Submarine Officer Career Path. (From: Navy Administration Training Manuals, Useful Information For Newly Commissioned Officers, NAVEDTRA 12967, November 1992 View D).

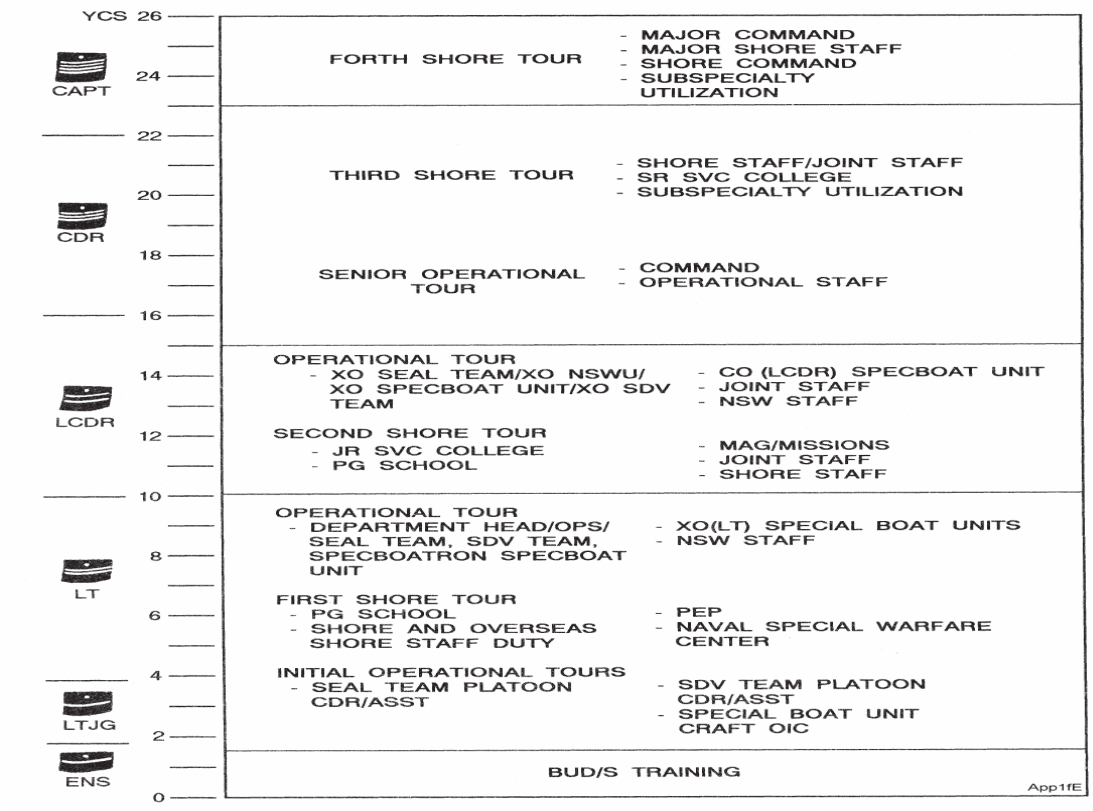


(4) Special Warfare. The Special Warfare Officer develops a skill area such as unconventional warfare, counter-insurgency, coastal and reverie interdiction, and tactical intelligence collection. The first course for the Special Warfare

[46] The U.S. Naval Academy Webpage, "Submarines," http://www.usna.edu/Submarines/career.html, (Accessed January 6, 200).

is a six-month physically and mentally demanding Basic Underwater Demolition/SEAL (BUDS) Training. In this training, officers learn all forms of Naval Special Warfare such as hydrographic reconnaissance, land and underwater demolitions, individual and crew served weapons, small unit tactics, land reconnaissance, and various types of SCUBA. After this training, they become SEAL Officers. The first assignment for a SEAL Officer usually is as an assistant Platoon Commander. During this duty, they also continue their training, expanding the basic skills learned during BUDS Training and learning new areas such as parachuting and SEAL Delivery Vehicle Operations. A new SEAL officer will also receive extra training before an assignment to a Naval Special Warfare Unit or an Amphibious Ready Group.[47] Table 6 shows the career path of the Special Warfare Officers.

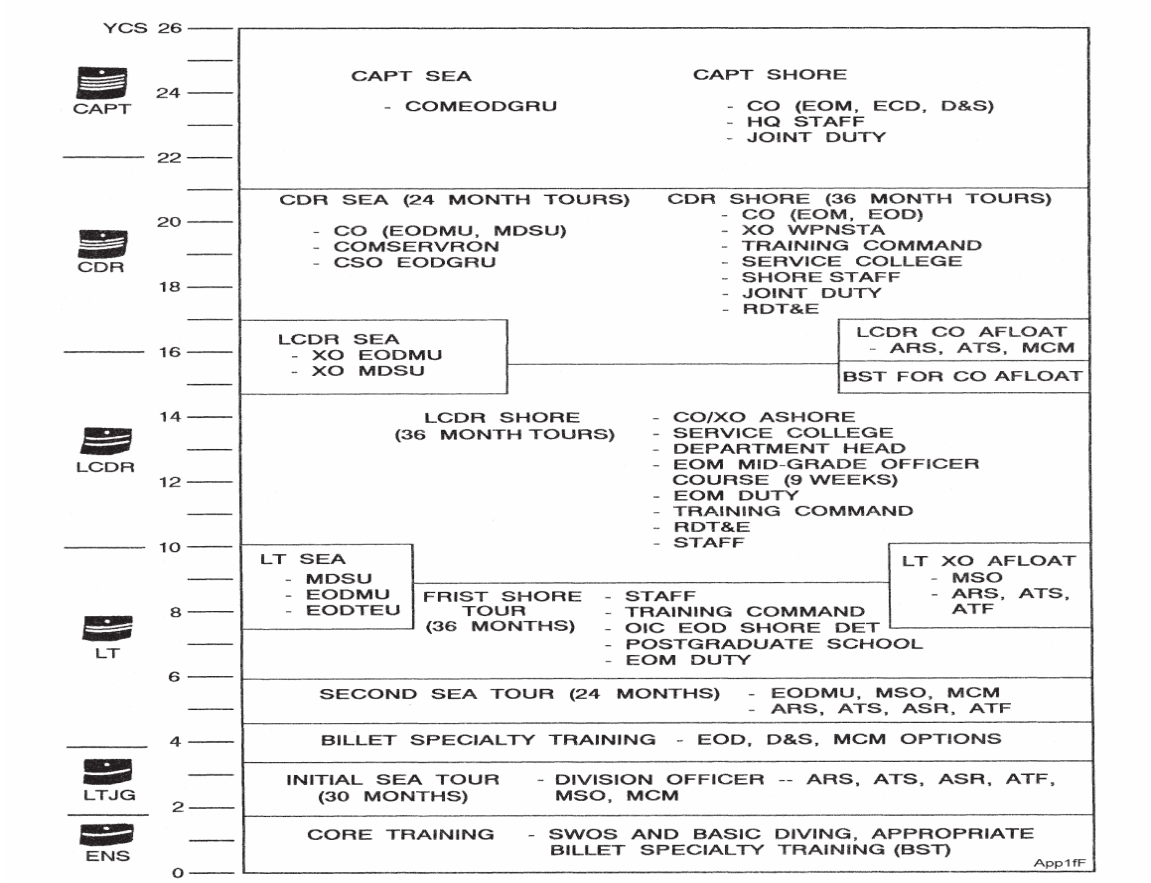
Table 6. The Career Path of Special Warfare Officers. (From: Navy Administration Training Manuals, Useful Information For Newly Commissioned Officers, NAVEDTRA 12967, November 1992 View E).



[47] University of Kansas – NROTC Web Page, "*Battalion Resources: Chapter 11*," http://www.ku.edu/~kunrotc/battalion_regs/chap_11.htm#1101, (Accessed January 10, 2005).

(5) Special Operations (SPECOPS). As the newest warfare community of the Navy, Special Operations provides service in four areas: explosive ordnance disposal, diving and salvage, expendable ordnance management and mine countermeasures. The Special Operations Community is responsible for all aspects of Navy diving and salvage. Diving is the common base for all four areas. The Special Operations Officers must learn all types of diving such as surface supplied, mixed gas, and saturation Also, conventional and nuclear weapon production, renovation, and logistic support are within the scope of a SPECOPS officer's duties.[48] Table 7 shows the career path of Special Warfare Officers.

Table 7. The Career Path of Special Warfare Officers. (From: Navy Administration Training Manuals, Useful Information For Newly Commissioned Officers, NAVEDTRA 12967, November 1992, View F).



[48] University of Kansas – NROTC Web Page, "*Battalion Resources: Chapter 11*," http://www.ku.edu/~kunrotc/battalion_regs/chap_11.htm#1101, (Accessed January 10, 2005).

b. Navy Restricted Line Officer Communities

Due to medical or other reasons, some midshipmen in the USNA or NROTC Units are not qualified for an unrestricted line assignment and they may be assigned to Restricted Line (RL) Communities. Most of the accessions for these communities are transferred from Unrestricted Line Communities after the first sea tour.[49] Also, a large number of RL Officers come from OCS. The RL consists of the following eight communities: 17% Engineering Duty Officer (EDO); 17% Aviation Maintenance Duty Officer (AMDO & AEDO); 16% Cryptology; 28% Intelligence; 4% Public Affairs Officer (PAO); 8% Oceanography; 13% Human Resource (HR); and 7% Information Professional (IP).[50]

(1) Engineering Duty Officer Community. Engineering Duty (ED) officers provide technical expertise, practical engineering judgment and business acumen to the research, development, design, acquisition, construction, lifecycle maintenance, modernization and disposal of ships and submarines and their associated warfare support systems in the areas of hull, mechanical and electrical; combat weapons and ordnance; and command, communications and electronics.[51] Only a few highly selected officers from warfare communities, after four-eight years at sea, become Engineering Duty officers. They must complete a Master's Degree Program in an Engineering or Physical Science discipline before assignment. ED officers are then assigned to the ED Basic Course at ED School, Port Hueneme, California to complete the ED Qualification Program. After that course, Engineering Duty Officers follow one of the three basic ED career areas: (1) Fleet Maintenance and Industrial Management; (2) Systems Engineering; and (3) Acquisition Program Management. Although these career areas differ from each other at some points, the following figure describes a typical ED career path.

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[49] University of Kansas – NROTC Web Page, "*Battalion Resources: Chapter 11*," http://www.ku.edu/~kunrotc/battalion_regs/chap_11.htm#1101, (Accessed January 6, 2005).

[50] Joseph P. Mooney and Juliet A Cook. *A Performance Analysis of the Officer Lateral Transfer and Redesignation Process*," (Monterey, California: Naval Postgraduate School, March 2002), 7. http://library.nps.navy.mil/uhtbin/cgisirsi/Thu+Jan+27+16:50:38+PST+2005/SIRSI/0/518/0/04Sep_Mooney.pdf/Content/1?new_gateway_db=HYPERION, (Accessed February 12, 2005).

[51] The U.S. Engineering Duty Officers Web Page, "*Planning*," http://www.bupers.navy.mil/edo/planning.htm, (Accessed January 11, 2005).

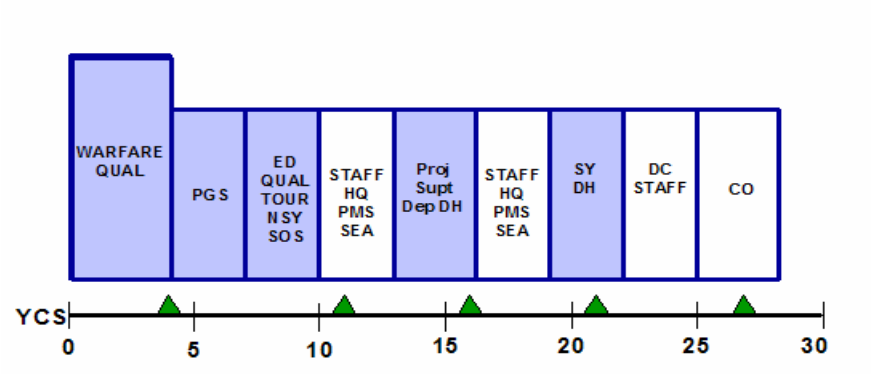

Figure 2. The Career Path of Engineering Duty Officers. (From: Engineering Duty Officers Official Web Page, http://www.bupers.navy.mil/edo/planning.htm, (Accessed January 6, 2005)).

(2) Aviation Maintenance Duty Officer. Aviation Maintenance Duty Officers (AMDOs) are responsible of providing full-time, professional aircraft maintenance to the Navy's aircrafts. In addition to working in fleet maintenance organizations, AMDOs deal with material acquisition and support as Program Managers in NAVAIR and as Commanding Officers of the Naval Aviation Depots.[52] AMDO entry level accessions come from the Naval Academy, AOCS, OCS, ROTC and flight school attrites. Officers with technical degrees are preferred, such as Aeronautical/Mechanical/Electrical Engineering, Math or other hard sciences.

AMDOs start their professional education with an 11-week course at the Aviation Maintenance Officers School in Milton, Florida near Pensacola.[53] Mid-grade officers attend a two-week Senior Aviation Maintenance Officers course. They obtain their Master's Degree at the Naval Postgraduate School. Sea/shore rotation continues from Ensign through Commander. At the beginning of their careers, they usually work in all types of squadrons and Aircraft Intermediate Maintenance Departments. In the middle of their careers, they serve as air wing maintenance officers, assistant AIMD officers, AIMD production control officers, L-Class ship AIMD officers

[52] The U.S. Naval Personnel Command Web Page, "*AMDO*," http://www.npc.navy.mil/Officer/AMDO/, (Accessed January 15, 2005).

[53] The U.S. Navy Aviation Maintenance Duty Officer (AMDO) Association Web Page, http://www.amdo.org, (Accessed January 16, 2005).

and in staff tours both in the fleet and in Washington. The highlight of the Commander years is a tour as an AIMD officer, which the community equates to the aviator's squadron command tour.[54]

(3) Cryptology Officer. Cryptology officers enter the service as new accessions or lateral transfers. All candidates must be eligible to receive a Top Secret/SCI clearance. They must have a technical background, mostly degrees in engineering, math, physics or computer science. After entering, they attend the Naval Cryptologic Officer Basic Course (NCOBC) at NTTC Corry Station, Pensacola, Florida. They learn the fundamentals of Cryptology in this five-week course.[55]

After graduation, they are assigned to the National Security Agency or one of the Naval Security Group field activities worldwide. They will work in the areas of collection, analysis and reporting, administration, communications, or information systems security. Second tours may include assignment to sea duty, the National Security Agency, Washington, D.C. Staff, systems research and development or graduate education. In the more senior grades (04 - 06), a Cryptology officer can expect both naval and joint staff assignments, duty as a commanding officer, executive officer of NSG activities or executive officer at a NCTS or NCTAMS.[56]

(4) Intelligence Officer. Naval Intelligence is the oldest continuously operating U.S. Intelligence service, established in 1882. The majority of Naval Intelligence personnel, civilian and military, are assigned to the Office of Naval Intelligence (ONI). ONI is located in the National Maritime Intelligence Center in Suitland, Maryland. Other Naval Intelligence personnel are located in Joint Intelligence Centers, in Cytological Elements and within Fleet Operations worldwide.[57]

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[54] The U.S. Navy Aviation Maintenance Duty Officer (AMDO) Association Web Page, http://www.amdo.or, (Accessed January 16, 2005).

[55] The U.S. Naval Personnel Command Web Page, http://www.npc.navy.mil/NR/rdonlyres/6B957313-F213-4651-B99F-CF984E06855B/0/CommunityInfo_InitialTraining.doc, (Accessed January 13, 2005).

[56] Naval Personnel Command Web, http://www.npc.navy.mil/NR/rdonlyres/2F4250B3-0EE4-447E-BA82-096C419E432F/0/CommunityInfo_SubsequentToursofDuty.doc, (Accessed January 18, 2005).

[57] United States Intelligence Community Web Page, http://www.intelligence.gov/1-members_navy.shtml, (Accessed January 18, 2005).

An Intelligence Officer is required to conduct investigations, perform research, analyze information, and must be able to prepare clear and concise reports on national security-related matters. For an Intelligence officer, a high-quality academic background, with special emphasis on communications and analytical skills, basic literacy in scientific processes and mathematics and demonstrated degree of self-confidence is needed. Foreign language capability is considered a plus, but is not a key requirement for accessions. Those language skills considered useful to the community are Mandarin Chinese, Arabic, Farsi, Russian, Spanish, Japanese, French and German.[58]

All intelligence officers receive their educational start to their careers at the Navy Intelligence Officer Basic Course (NIOBC), which provides insight into the entire spectrum of the intelligence community. After graduating from basic intelligence training, Intelligence officers go to a 30-month operational fleet tour. This is typically an assignment with an aviation squadron, air wing staff, or onboard an aircraft carrier or amphibious command ship.

On the second or third tour, the intelligence officer is afforded formal training opportunities that include the Naval Intelligence Intermediate Course (NIIC). In addition, there are a number of other formal educational prospects available to these officers. While most career paths are varied, the Navy Intelligence Officers serve three sea duty assignments within a 20-year career.[59]

(5) Public Affairs. It can be said that the Navy Public Affair officers are the eyes and ears of the fleet. They are responsible for the effective delivery of information in the form of visual, audio and written communications, both internal and to the public. They also plan activities to improve public relations. Public Affairs officers attend Defense Information School in Ft. Mead, Maryland prior to their first duty station. This 10-week advanced training course includes principles of public information and community relations and Department of Defense policies.[60]

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[58] University of Kansas – NROTC Web Page, "*Battalion Resources: Chapter 11*," http://www.ku.edu/~kunrotc/battalion_regs/chap_11.htm#1101, (Accessed January 18, 2005).

[59] The U.S. Naval Personnel Command Web Page, "*Intelligence Officer*," http://www.npc.navy.mil/Officer/Intelligence/OfficerAccession/, (Accessed January 18, 2005).

[60] College grad.com Web Page, "*The U.S. Navy, Human Resources*," http://www.collegegrad.com/careers/navy11.shtml, (Accessed January 18, 2005).

(6) Oceanography Officer. The Navy Oceanography Community's mission is to collect, interpret and apply global data and information for safety at sea, strategic and tactical warfare, and weapons system design, development and deployment. For Navy Oceanography Officers, a degree in either meteorology or physical oceanography is strongly preferred. Physics or mathematics is an acceptable alternative.[61] All Oceanographers will be required to qualify for and graduate from the Naval Postgraduate School with a M.S. in Meteorology and Oceanography early in their careers. Oceanography personnel must be qualified medically to go to sea and overseas, and be eligible for a secret or top secret clearance.[62] Table 8 shows the professional career path of Navy Oceanography officers.

Table 8. The Career Path of the Navy Oceanography Officers. (From: Naval Personnel Command Web Page http://www.persnet.navy.mil/pers449/index.html, (Accessed January 20, 2005).

[61] The U.S. Naval Personnel Command Web Page, "*Pers449*," http://www.persnet.navy.mil/pers449/index.html, (Accessed January 18, 2005).

[62] University of Kansas – NROTC Web Page, "*Battalion Resources: Chapter 11*," http://www.ku.edu/~kunrotc/battalion_regs/chap_11.htm#110, (Accessed January 18, 2005).

(7) Human Resources Officer. The Chief of Naval Personnel has stated that "the HR Officer will serve as the Navy's expert in developing, shaping, and aligning the future forces to meet mission requirements, transforming the recruiting and military distribution systems, achieving a technology-based Human Resource System and fully aligning the military manpower and personnel strategy into an effective Navy Human Resource Strategy."[63] HR Officers must supervise the Navy HR functions and advise all Navy leadership on HR systems. Figure 3 shows typical Navy Human Resources Career path.

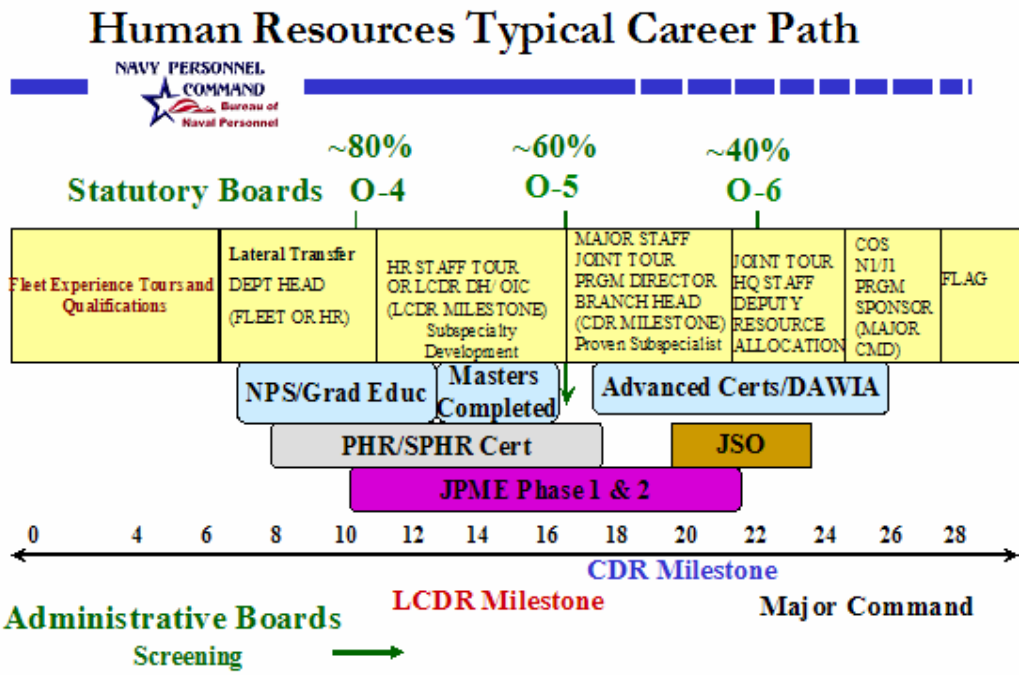


Figure 3. The Career Path of the Navy Human Resources Officers. (From: Naval Personnel Command Web Page http://www.npc.navy.mil/Officer/HumanResources/Career+Paths.htm, (Accessed January 16, 2005)).

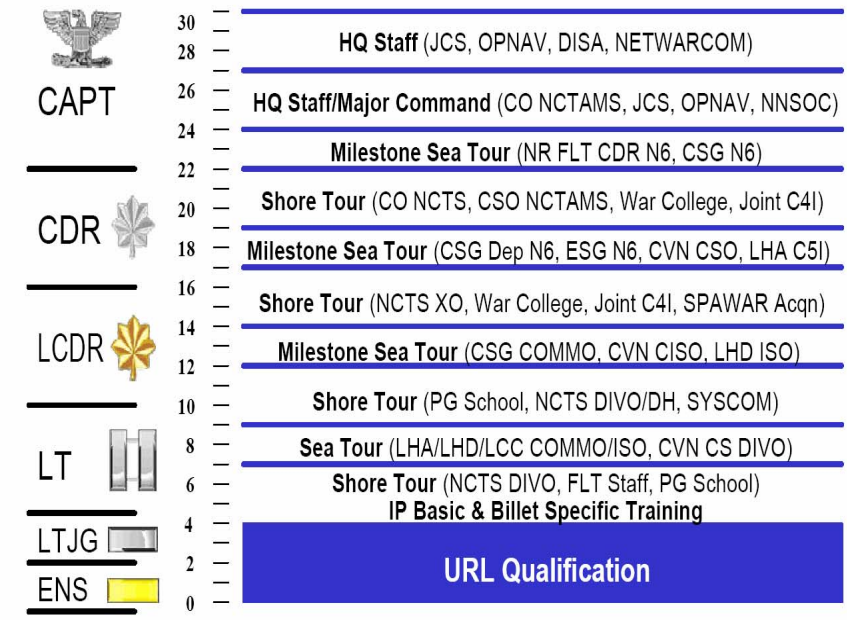
(8) Information Professional (IP) Officers. Information Professional (IP) officers are the Navy's Information Warriors with expertise in

[63] J. Harry Barber, *The Navy Human Resource Officer Community: Assessment and Action Plan*, (Monterey, California: Naval Postgraduate School, June 2003), 18, http://library.nps.navy.mil/uhtbin/cgisirsi/Thu+Jan+27+17:11:06+PST+2005/SIRSI/0/518/0/03sep_Barber.pdf/Content/1?new_gateway_db=HYPERION, (Accessed January 8, 2005).

information, command and control and space systems. They are responsible for operating, maintaining and securing the Naval Network and the information systems that support the Navy's functions.

Most of the IP officers come to this community as lateral accessions as LTJGs, LTs or junior LCDRs. They work both at sea and on shore. IPs are assigned to sea billets on Battle Group Staffs and Ships at each grade. Shore tours include C4I/Space/Surveillance billets on major Navy and joint staffs as well as command of key communication and surveillance facilities around the globe.[64] Table 9 shows the career path of IP officers.

Table 9. The Career Path of the Navy Information Professional Officers. (From: Naval Personnel Command Web Page http://www.bupers.navy.mil/pers4420/MISC%20Documents/IP%20CareerPath.pdf, (Accessed January 16, 2005).



c. Navy Staff Officer Communities

(1) Civil Engineering Corps (CEC) Officer. The Civil Engineer Corps is made up of the Navy's environmental and natural resource managers.

[64] The US. Naval Personnel Command Web Page, http://www.bupers.navy.mil/pers4420/IP_TRI-FOLD/IPTRI%20Oct%2004.pdf, (Accessed January 18, 2005).

The CEC serves as the Navy's expert for ocean, near shore and underwater and shore based engineering facilities. Accessions are primarily civil, mechanical, or electrical engineering majors, and will primarily come from accession programs other than NROTC. The Navy Civil Engineer Corps Officers begin their careers with the Basic Course at Civil Engineer Corps Officers School (CECOS) located in Port Hueneme, California. The Basic Course consists of eight weeks of CEC orientation along with seven weeks of basic government contracting principles for a total of 15 weeks. Also, they attend graduate school after they have been in the Navy at least four years but before they have 10 years of service. In this graduate education, they commonly pursue degrees in Environmental, Civil, Mechanical, Electrical, Ocean Engineering, Financial Management, and Information Technology Management.[65] Figure 4 shows the professional career path of Navy Civil Engineering Corps officers.

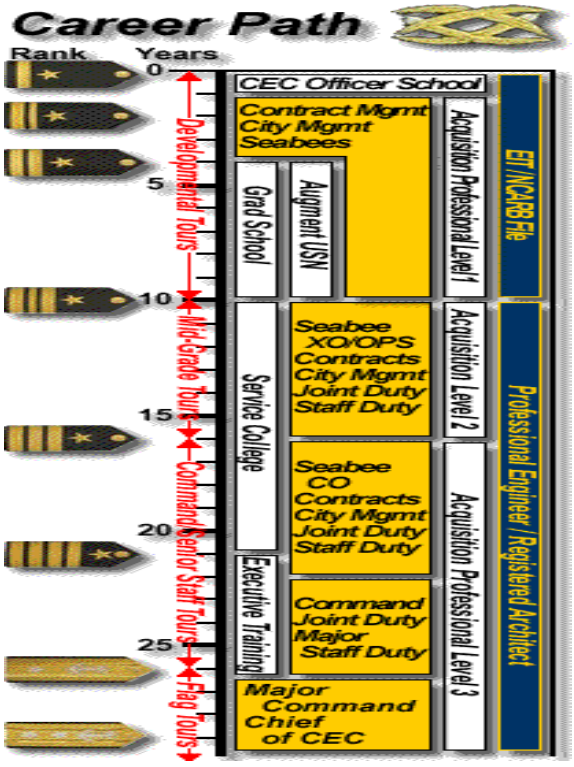
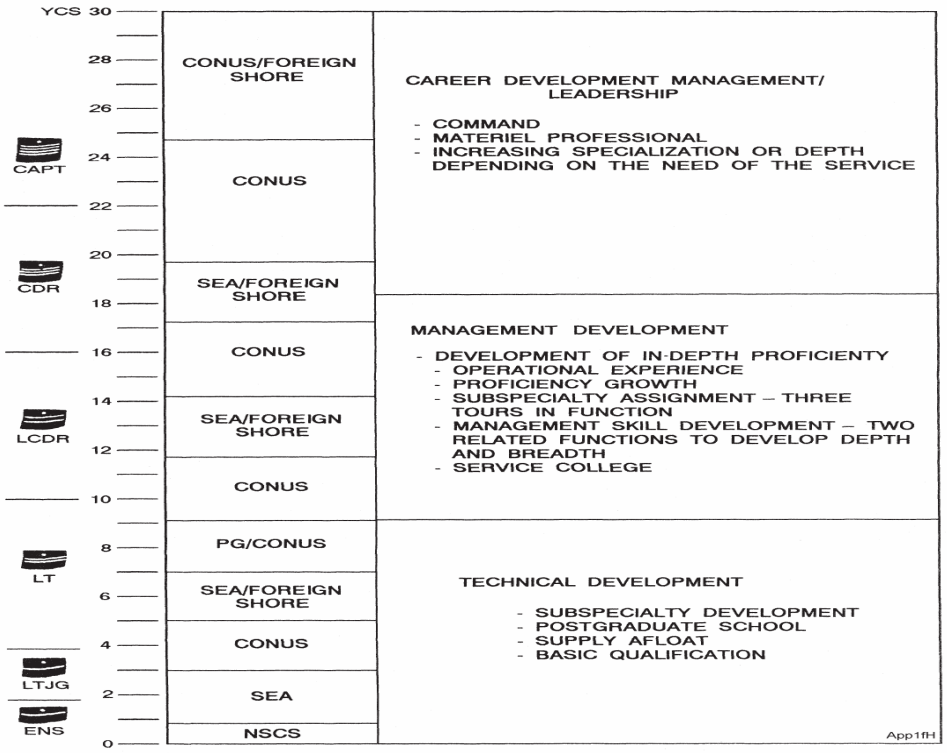


Figure 4. The Career Path of the Navy Civil Engineering Officers. (From: The U.S. Navy Civil Engineering Corps Web Page, http://www.cec.navy.mil/default.htm?ceccareer.html, (Accessed January 16, 2005)).

[65] The U.S. Navy Civil Engineering Corps Web Page, http://www.cec.navy.mil/default.htm?miscjobs.html, (Accessed January 16, 2005).

(2) Supply Officer. The main mission of the Navy Supply Corps Officers is to provide expertise in logistics, acquisition and financial management to the Navy. It can be said that they are the Navy's business managers. They should have a business or business related degree with significant quantitative courses including calculus. Navy commissioned officers who enter the Supply Corps attend the Navy Supply Corps School (NSCS) in Athens, Georgia before their first operational duty assignment. The Supply Corps Officer Basic Qualification Course (BQC) is designed to prepare Supply Corps officers to fulfill their initial professional duties. After completing the Basic Qualification Course at the Navy Supply Corps School, they begin a standard sequence of assignments, consisting of an assignment afloat, U.S. shore duty, foreign shore duty or a second assignment or a return to U.S. shore duty.[66] Figure 9 shows the professional career path of Navy Civil Engineering Corps officers.

Table 10. The Career Path of the Navy Supply Officers. (From: Navy Administration Training Manuals, Useful Information for Newly Commissioned Officers, NAVEDTRA 12967, November 1992, View H).



[66] The U.S. Naval Supply Systems Command Web Page, http://www.navsup.navy.mil/npi/supply_corps/officers/mg.jsp, (Accessed January 13, 2005).

(3) Fleet Support. The mission of the Fleet Support Community is "to support fleet and joint operations through management of the fleet support establishment and development of highly specialized technical and analytical capabilities."[67] Fleet Support Officers are mainly URL officers accessed at the rank of lieutenant and above by lateral transfer and redesignation.[68] Fleet Support Officers develop expertise in both their core competency area which are Manpower, Financial Management, Information Systems Technology and reserve management. Expertise can be developed by graduate degree followed by experience tours. All of the Core Competency areas incorporate various subspecialties, and movement between core competencies is anticipated to ensure optimum career development, leadership opportunities, and subspecialty development.

(4) Chaplain Corps. The mission of the Navy Chaplain Corps is mainly providing ministry across the Sea Services. Navy chaplains serve not only within the Department of the Navy, but with other services as well. They currently support the Navy, Marine Corps, Coast Guard, and Merchant Marine and serve in many joint force commands. Chaplains serve at all levels of the armed forces, from individual ships and smaller ground force units (battalion level) to the Office of the Secretary of the Navy.[69]

Before entering in the service, a Navy chaplain must have earned a Master of Divinity degree from an accredited seminary or have earned 90 semester hours of credit from an accredited seminary or theological school and have obtained an ecclesiastical endorsement from an Ecclesiastical Endorsing Organization recognized by the Department of Defense (DOD) besides possessing a bachelor's degree. Also, in most cases, they are required to have three years of civilian ministry experience. They may

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[67] The U.S. Fleet Support Officers' Association Web Page, http://www.nps.navy.mil/fsoa/, (Accessed January 13, 2005).

[68] Rhonda M. Henderson, *Fleet Support Officers Fleet Training (FSOFT); Should a Sea Tour be a Requirement?*, (Monterey, California: Naval Postgraduate School, June 2003), 8, http://library.nps.navy.mil/uhtbin/cgisirsi/Thu+Jan+27+17:23:47+PST+2005/SIRSI/0/518/0/00Jun_Henderson.pdf/Content/1?new_gateway_db=HYPERION, (Accessed January 15, 2005).

[69] Karen D. Smith et al., "Promotions in the Navy Chaplain Corps," (Alexandria, Virginia: Center for Naval Analysis, March 2000), http://www.navychaplain.faithweb.com/about.html, (Accessed January 15, 2005).

receive additional credit for time spent in civilian ministry (seven or more years of ministry equates to one year credit). Thus, chaplains are commissioned at a range of grades.[70]

(5) Judge Advocate Generals (JAG). JAGs are responsible for advising and providing legal assistance to the Navy personnel on matters of law arising within the Department of the Navy, and management and implementation of the Navy's criminal justice system. Wherever assigned, JAG Corps officers perform legal or administrative duties as legal counsel.

JAG officers attend Officer Indoctrination School (OIS) in Newport, Rhode Island. OIS is a six-week course of instruction designed to inform newly commissioned officers of the customs and traditions of the naval service. OIS is the first step in the JAG Corps training pipeline and is normally attended after completion of the bar examination. After OIS, the new JAG officers attend the Basic Lawyer Course at Naval Justice School (NJS) in Newport, Rhode Island. This is a nine-week course and the training is mostly about civil and military law. After graduation, JAG officers report to the Naval Legal Service Office in Norfolk, Virginia for a week of naval orientation. After that, they are normally assigned to Naval Legal Service offices, or Trial Service offices, usually within the continental United States.[71]

(6) Medical Community. The Medical Department of the Navy is composed of the medical corps, the dental corps, the medical service corps, and the nurse corps. The mission of the Navy Medical Department Officers is to support the Navy through the effective and responsive distribution of medical assets to fulfill operational commitments.[72]

Nurse Officers may be commissioned through the NROTC program. Also, they may be commissioned through the Nurse Commissioning Program of Direct Appointment[73]. The medical corps, the dental corps and the medical service

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[70] Ibid.

[71] The U.S. Navy JAG Corps Web Page, http://www.jag.navy.mil/html/jag_career_stages.htm=, (Accessed January 16, 2005).

[72] The U.S. Naval Personnel Command Web Page, http://www.npc.navy.mil/Officer/MedicalAssignments/, (Accessed January 16, 2005).

[73] Tamara K. Maeder, *The Costs and Benefits of the Navy Nurse Corps Accession Sources*, (Monterey, California: Naval Postgraduate School, December 1999), 12.

corps are usually commissioned through Officer Candidate Schools and Direct Appointment. After commissioning, Medical Department Officers are assigned to a variety of clinical environments, from large hospitals to clinics, aboard ships and in educational settings in the United States and overseas.

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III. LITERATURE REVIEW

A. OVERVIEW

Turnover has been a managerial concern for public and private organizations for a long time. Turnover is simply the number of people who enter or leave the organization. Retention is the inverse of turnover. When an employee leaves the organization, the organization generally experiences costs related to the employee's separation. These costs may be decreased productivity, costs related to hiring a new employee and other indirect costs. Also, high turnover (low retention) rates may affect employee morale and the tempo of the organization. High turnover may be very disruptive for organizations. In the Navy, low retention (high turnover) increases overall personnel cost, decreases officer quality, increases recruiting efforts and reduces overall productivity.[74]

After the beginning of the 20th century, there have been many studies about turnover.[75] Due to these problems related to turnover, organizations try to monitor employee turnover closely and understand the factors that influence it.[76] The first step in measuring turnover is defining it generally as a movement out of the organization. It is usually expressed as a percentage and computed as the number of employees who separate divided by the total number of the employees in the organization in a given period.

$$\text{Turnover Rate:} \quad \frac{\text{Number of employee separations during the month}}{\text{Total number of employees at midmonth}}$$

Turnover rates differ among organizations, industries, departments, occupations, geographic locations and by employee characteristics.[77] In order to reduce turnover rates, organizations must understand the cause of the turnover. Turnover can be classified as voluntary or involuntary. Involuntary turnover occurs when an employee is discharged or

74 Gabriel T. Clemens, *An Analysis of Factors Affecting the Retention Plans of Junior U.S. Navy Officers,* (Monterey, California: Naval Postgraduate School, March 2002), 6.

75 T. M. Cotton, and J. Tuttle*, Employee Turnover: a Meta- Analysis and Review with Implications for Research*, *Academy of Management Review*, 1986, VII(1), 55–70.

76 SHRM Web Page, SHRM Information Center. *Employee Turnover: Analyzing Employee Movement Out of the Organization*, www.shrm.org, (Accessed February 2, 2005).

77 Ibid.

terminated. Voluntary turnover occurs when an employee leaves the organization by his own choice, which may be caused by many factors. The factors that cause turnover may include employment perceptions, unemployment rate, accession rate, union presence, pay, performance, role clarity, task repetitiveness, overall satisfaction, pay satisfaction, satisfaction with work itself, satisfaction with supervision, satisfaction with co-workers, satisfaction with promotion, organizational commitment, as well as, age, tenure, gender, education, marital status, number of dependents, aptitude and ability, intelligence, behavioral intentions and met expectations.[78]

Given that turnover is very important to the well-being of organizations, since the beginning of 1900s, a huge amount of effort has been expended to understand the factors that affect it and hundreds of civilian and military studies have contributed to turnover research.[79]

B. LITERATURE DISCUSSION

1. Civilian Studies on Turnover

a. Cotton and Tuttle (1986)

Cotton and Tuttle conducted a meta-analysis of 131 studies on employee turnover. They collected 26 variables that affect turnover into three types: external variables, work related variables and personal variables. They considered external variables as employment perceptions, unemployment rate, accession rate, and union presence; work related variables as pay, performance, role clarity, task repetitiveness, overall satisfaction, pay satisfaction, satisfaction with work itself, satisfaction with supervision, satisfaction with co-workers, satisfaction with promotion, and organizational commitment; and personal variables as age, tenure, gender, biographical data, education, marital status, number of dependents, aptitude and ability, intelligence, behavioral intentions, and met expectations.[80]

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[78] Gerry L. Wilcove, et al., *Officer Career Development: A Review of the Civilian and Military Research Literature on Turnover and Retention,* (San Diego, California: Naval Personnel Research and Development Center, 1991.)

[79] T. M. Cotton, and J. Tuttle*, Employee Turnover: a Meta- Analysis and Review with Implications for Research*, *Academy of Management Review*, 1986, VII (1), 55–70.

[80] Ibid.

Their meta analysis found that, among external variables, employment perceptions and union presence are highly significant (<.0005). Employment perceptions are positively related, and union presence is negatively related to turnover and significant (<.001). The unemployment rate is negatively related and moderately significant (<.01). The accession rate shows a weak significance and positive relation to turnover.[81]

In their study, they showed that many of the work-related variables are highly correlated with turnover. Pay is highly significant and positively correlated with turnover. Overall satisfaction, pay satisfaction, satisfaction with work itself, satisfaction with supervision and organizational commitment are also highly significant and negatively correlated with turnover. Job performance, satisfaction with co-workers, satisfaction with promotion and role clarity were also significant and negatively related to turnover. The Meta analysis for task repetitiveness demonstrated only weak significance and positive correlation with turnover.[82]

Among the personal variables, age, tenure and number of dependents are significant and negatively related to turnover. Education and behavioral intentions are highly significant and positively correlated to turnover. People with met expectations are significantly less likely to leave the organization. Also they found that the gender variable is strongly significant, and women are more likely to leave than men. Married people are significantly less likely to leave than single people. The meta analysis showed no relationship between intelligence and turnover.[83]

b. Werbel and Bedeian (1989)

In this study, the authors investigated the influence of personal variables as an antecedent of intention to quit the job. They tried to "evaluate the interaction effect of age and performance with intended turnover and tried to determine if age differentially affects the turnover intentions of better and poorer performers."[84]

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[81] T. M. Cotton, and J. Tuttle*, Employee Turnover: a Meta- Analysis and Review with Implications for Research*, *Academy of Management Review*, 1986, VII (1), 55–70.

[82] Ibid.

[83] Ibid.

[84] James D. Werbel and Arthur G. Bedeian, *Intended Turnover as a Function of Age and Job Performance,* Journal of Organizational Behavior Vol. 10, No. 3, 1989, 275-281.

The results of the study indicated that age is a significant indicator between performance and intention to quit. That means there is a difference in the relationship between performance and intentions to quit for younger and older employees. Older employees with poor performance are the least likely to leave the job because of the difficulty of finding a new job. In this way, they tried to show the relationship between age, performance and turnover.[85]

c. Lee and Mitchell (1994)

This study focuses on job satisfaction and its effect on employee turnover. Lee and Mitchell used "image theory" to state the link between job satisfaction and turnover. According to image theory, people are bombarded with information that attempts to change their behavior. However, they usually keep the status quo, in spite of these external effects. Most of the time, the information that tries to change people's minds passes a screening process and is rejected. However, in some situations, some options survive the screening process. The screening process is simply the comparison of the new information or option with the relevant content learned before. Images are very important in the screening process, because most of the time, people decide with the help of their images. The main images are work, family, friends, recreation, and ethics/spiritual.[86]

They stated that there are mainly four main possible decision paths to turnover. The first one is when an employee faces a shock to the system, which is a situation quite different from the normal situation. "A shock to the system is theorized to be a very distinguishable event that jars employees toward deliberate judgments about their work, and perhaps to voluntarily quit their job."[87] This shock may be positive or negative. For example, an employee may think about quitting the job when he or she inherits a large amount of money. The second decision path occurs when a shock to the system makes an employee evaluate his or her detachment to the organization. The third decision path is when the employee thinks about the possibility of detaching to a new

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[85] James D. Werbel and Arthur G. Bedeian, *Intended Turnover as a Function of Age and Job Performance, Journal of Organizational Behavior*, Vol. 10, No. 3, 1989, 275-281.

[86] Thomas W. Lee, and Terence R. Mitchell, *An Alternative Approach: The Unfolding Model of Voluntary Employee Turnover*, *Academy of Management Review*, 1994, Vol. 19, No. 1, 60.

[87] Ibid.

organization. He or she thinks about other job possibilities. The fourth decision path occurs when, after some time, the employee realizes that his or her values do not fit with the organization, and so might decide to leave. In their study, the authors tried to bring a new approach to the classic approach to the causes of employee turnover with the four decision paths.

d. Somers and Birnbaum (1999)

In this research, Somers and Birnbaum studied the application of survival analysis methods versus traditional methods to the subject of employee turnover. They stated that, traditional methods, ordinary-least squares and logistic regression, described turnover as "a binary outcome variable that, at some point changes state from stayer to leaver."[88] They mentioned that survival methods are less subject to methodological problems including " …arbitrary classification of stayers and leavers based on measurement windows and bias in parameter estimates stemming from censored data."[89] As a result of the methodological advantage of survival methods, they stated that these methods are more advantageous for the study of turnover because they are more likely to produce accurate predictions of turnover.

They focused on three types of survival analysis studies, demonstrations of the use of survival analysis methods on turnover, use of survival and hazard functions to estimate the intensity of turnover over time, and use of regression analogs of survival analysis to test turnover.[90]

In their study, survival methods were compared to traditional methods in turnover research. Their results indicated significant differences between these two methods. They found that traditional methods indicated job withdrawal intentions as the predictor of employee turnover behavior parallel to the vast majority of the research. However, survival methods indicated continuance commitment and ethnicity as

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[88] Mark John Somers and Dee Birnbaum, *Survival versus Traditional Methodologies for Studying Employee Turnover: Differences, Divergences, and Directions for Future Research*, Journal of Organizational Behavior, Vol. 20, p. 273.

[89] Ibid.

[90] Ibid.

predictors of turnover. They found that the results of the survival method are more meaningful. In explaining why survival methods are more meaningful, they supported their thesis with findings from Lee and Mitchell's (1994) study.[91]

2. Military Studies on Turnover

The literature on the retention and career development of U.S. Navy officers has been growing parallel to advancements in the computer technology and building of personnel data files. Although civilian turnover research is helpful in understanding some of the turnover issues that face the Navy, looking at military turnover research to understand the military-specific aspects of these issues fully is beneficial.

a. Bowman (1995)

Bowman's study is the first that applies cost analysis to the different commissioning programs in a steady state environment.[92] In his study, he analyzed the retention and promotion of Navy unrestricted line and restricted line community officers who were commissioned in the years between 1976 through 1981. For this study, he merged actual Officer Data Card information with promotion and selection board results. He used demographic and human capital variables in his research.

His results show that USNA graduates are more likely to be promoted and stay on active duty compared to accessions from other officer commissioning sources. At first glance, without considering the career life time of USNA graduates, spending an average of nearly $200,000 for a USNA graduate officer appeared to be very expensive, but it can be a cost-effective decision. Due to the high turnover among OCS graduates, spending only $28,523 for OCS officers is generally not a cost-effective decision. In evaluating the commissioning sources, Bowman used the steady state number of accessions in URL communities. Also, he computed total discounted lifecycle costs per officer as the product of total discounted training costs (pre-and post commissioning) and

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[91] Mark John Somers and Dee Birnbaum, *Survival versus Traditional Methodologies for Studying Employee Turnover: Differences, Divergences, and Directions for Future Research*, Journal of Organizational Behavior, Vol. 20, p. 273.

[92] William R. Bowman, *Cost Effectiveness of Service Academies: New Evidence from Navy Warfare Communities,* (Annapolis, Maryland:U.S. Naval Academy, June 1995).

steady state accession requirements. He found that NROTC graduates are the most cost-effective commissioning source for NFOs and OCS graduates to be the most cost-effective source for Surface Warfare Officers.[93]

Also, Bowman found that, in spite of high costs of USNA and NROTC units, they reduce general turnover costs due to their long career lives. Also, he acknowledges that the voluntary stay or leave decision before promotion to the O-4 point is not strongly related to commissioning source, but more likely related to initial experience in the service and marital status.[94]

b. Hosek et al., 2001

With the passage to the all Volunteer Force in the U.S. Military, the number of female officers and the number of officers belonging to the minority races increased. To keep the diversity of the senior officers, the same as the diversity of the junior officers, women and minorities should be retained and promoted at the same rate of the other officers. Hosek et al. investigate whether female and minority officers are retained and promoted at the same rate with the other officers across the U.S. Military.[95] Although the main intention was the investigation of minority and gender differences in retention and promotion, this study was also beneficial to understanding the effects of commissioning sources on the career progression of officers.

The study focuses on the officers commissioned through the years 1961-1991. The data was provided by the Defense Manpower Data Center (DMDC). The data contains records of the race, ethnicity, gender, marital status, commissioning source, and military occupation of each officer. They measured retention and promotion by race, ethnicity, and gender at each rank, for ranks through O1-O5. Commissioning source was added to the model as an additional predictor variable.[96]

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[93] William R. Bowman, *Cost Effectiveness of Service Academies: New Evidence from Navy Warfare Communities,* (Annapolis, Maryland:U.S. Naval Academy, June 1995).

[94] Ibid.

[95] Susan D. Hosek et al., *Minority and Gender Differences in Officer Career Progression,* (Santa Monica, California: The Rand Corporation, 2001), http://www.rand.org/publications/MR/MR1184/index.html, (Accessed January 10, 2005).

[96] Ibid.

Generally, they found that men are more likely to reach O-4 and the higher ranks than women. Black male officers were more likely to fail to be promoted than white male officers, but they were more likely to stay in the military. Black females were both less likely to stay and promote than white male officers. As to differences between commissioning sources, officers commissioned through ROTC were more likely to stay in the military compared to the other commissioning sources. Naval Academy graduates are more likely to promote to the O-4 point than other officers commissioned through sources other than service academies.[97]

c. Fagan (2002)

In his study, Fagan examined the Naval Flight Officers (NFOS) commissioned from 1983 to 1990 and analyzed the training performance, retention and promotion to Lieutenant Commander (O-4). He defined training performance as successfully earning their "wings of gold". Retention is defined as remaining in the service beyond the minimum service to Lieutenant Commander (LCDR), and promotion is defined as selection for LCDR.[98]

In his models, Fagan used commissioning source, gender, race, age, education, training time and community platform as predictor variables. The results of his study showed that the amount of training time in earning their wings affects the overall success of the NFOs. After commissioning, the longer it takes an NFO to earn wings, the less likely he or she will promote to LCDR. The most important training in earning wings is flight school. Navy academy graduates were more successful in flight school and promotion to LCDR compared to NROTC and OCS graduates. Also, NFOs with technical degrees and prior enlisted experience are more likely to complete flight school. Lateral transfers to NFO are less likely to promote to the LCDR point because of the time constraint to earn the wings.[99] Lateral transfers from NFO to other communities are more likely to promote compared to their NFO peers.

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[97] Susan D. Hosek et al., *Minority and Gender Differences in Officer Career Progression,* (Santa Monica, California: The Rand Corporation, 2001), http://www.rand.org/publications/MR/MR1184/index.html, (Accessed January 10, 2005).

[98] Billy K. Fagan, Analysis of Determinants of Training Performance, Retention, and Promotion to Lieutenant Commander of Naval Flight Officers, (Monterey, California: Naval Postgraduate School, June 2002), 12.

[99] Ibid.

The results of his retention model showed that marriage, gender, age and prior enlisted service are significant while an undergraduate degree and ethnicity are not significant factors. In the promotion model, NROTC graduates have the lowest probability of promotion. Also, his promotion model showed that being married is an advantage for promotion, while being commissioned at an older age is a disadvantage.[100]

d. Clemens (2002)

In his study, Clemens investigated the factors that influence the retention intentions of Navy junior male officers who are within their initial obligated service. His data drawn from a 1999 DoD Survey. He used logistic regression methods in his research.[101]

He found the variables military rank, military occupation, family status, life expectations, satisfaction with military work values and satisfaction with military allocation of time significant in explaining the retention intentions of the Navy junior male officers. He found that officers in the ranks of O-2 and O-3 were less likely to intend to stay in the Navy than officers in the rank O-1. Also, he found that family status is a positive factor in retention intentions. A married officer is more likely to plan to stay in the Navy than a single officer.[102]

Clemens stated that an officer who received his or her choice of occupation in the Navy was more likely to intend to stay in the Navy. In addition, satisfaction with military work values and military allocation of time positively affect an officer's intention to stay in the Navy.[103]

e. Bernard and Mehay (2003)

Bernard and Mehay expanded Bowman's (1995) study in analyzing the effects of commissioning programs on retention and promotion of Naval Officers and the

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[100] Billy K. Fagan, Analysis of Determinants of Training Performance, Retention, and Promotion to Lieutenant Commander of Naval Flight Officers, (Monterey, California: Naval Postgraduate School, June 2002), 12.

[101] Gabriel T. Clemens, *An Analysis of Factors Affecting the Retention Plans of Junior U.S. Navy Officers,* (Monterey, California: Naval Postgraduate School, March 2002), 6.

[102] Ibid.

[103] Ibid.

cost effectiveness of each commissioning program.[104] They used marginal costs of commissioning sources instead of average costs in comparing commissioning programs, because "average cost allows for the possibility of closing a program and marginal cost assumes that policy decision is simply to expand/contract a program."[105] The data consist of information about Navy officers who were commissioned in the years 1983 through 1990. The data created from Navy Officer Data card information and annual promotion results through the O-4 promotion point.

The results of this study generally concurred with previous studies that USNA is the most cost-effective commissioning source except for the Surface Warfare Community where NROTC is the most cost-effective. Also, they found that accession source significantly affected the retention and promotion of officers. Their unrestricted line retention model showed that NROTC program accessions were more likely to stay on active service to the O-4 promotion board than USNA graduates. Also, their results suggest that officers who graduated from highly selective universities are less likely to stay in the service because of the high probability of finding better jobs in the civilian market. The results of the restricted line retention model showed that ROTC-Scholarship and OCS accessions are more likely to stay to the O-4 promotion point than USNA graduates. Having prior service experience had a positive effect on staying in the service for both URL and RL retention models. On the other hand, officers with technical degrees, who graduated from selective universities, and had high GPAs are less likely to stay in the service.[106]

The results of the promotion model showed that while USNA graduates were less likely to stay in the service to the O-4 point, they are more likely to promote to LCDR. Also, the graduates of elite universities are more likely to promote to the O-4 point. Fleet Support and Supply officers are less likely to promote and stay in the service to the LCDR point than other RL officers.[107]

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[104] Joel P Bernard, and Stephen L. Mehay, An Analysis of Alternate Accession Sources for Naval Officers. (Monterey, California: Naval Postgraduate School, May 2003).

[105] Ibid

[106] Ibid.

[107] Ibid.

f. Hoglin (2004)

In his study, Hoglin analyzed the determinants of the survival of United States Marine Corp Officers and developed a methodology to optimize the accessions of prior and non-prior enlisted officers.[108] He compiled his data from the Marine Corps Officer Accession Career file (MCCOAC). He constructed a Cox Proportional Hazards Model to estimate what affects USMC officers' survival. The findings from his model showed that prior enlisted officers in the USMC have a better survival rate than non-prior enlisted officers. Also, Hoglin found that "…officers who are married, commissioned through MECEP, graduate in the top third of their TBS class, and are assigned to a combat support MOS have a better survival rate than officers who are unmarried, commissioned through USNA, graduate in the middle third of their TBS class, and are assigned to either combat or combat service support MOS."[109] In addition, he found that commissioning age has a negative effect on the survival of officers, which means that every year added to the commissioning age of officers results in a decrease in their survival rates.

In the second part of his study, Hoglin constructed a Markov model to determine the optimum percentage of prior enlisted and non-prior enlisted accessions for the USMC under force structure and budget constraints. He found that the optimum mix differed from the actual mix. The result of his non-parametric model showed that the optimum percentage of prior enlisted officer accessions for the USMC is 22.4% and the optimum percentage of non-prior enlisted officers is 77.6%. By comparison, accessions in 1999 were 53.4 and 46.6% prior and non-prior, respectively.[110]

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[108] Phillip Hoglin, *Survival Analysis and Accession Optimization of Prior Enlisted United States Marine Corps Officers*, (Monterey, California: Naval Postgraduate School, March 2004), v.

[109] Ibid.

[110] Ibid.

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IV. METHODOLOGY AND DATA

A. OVERVIEW

This chapter discusses the methodology and data used to analyze the effect of commissioning source on officer longevity. This study uses survival analysis to examine this subject. The first part of the chapter is a brief description of the survival analysis methodology, including basic concepts such as censoring, the nature of survival data, the survival function, the hazard function, common ways of representing the probability distribution of event times, and background information needed to understand survival analysis methods. The second part of the chapter describes the SAS software procedures for survival analysis used in this thesis. The LIFETEST, LIFEREG and PHREG procedures are explained and the strengths and weaknesses of each procedure are discussed. The third part discusses the specifics and limitations of data, variable descriptions, and model specification.

B. METHODOLOGY

1. Basics of Survival Analysis

"Survival analysis is a class of statistical methods for studying the occurrence and timing of events."[111] These methods, as can be understood from their general name, are initially designed to study deaths or failure of a product. Also, they are useful in studying many different events in different sciences.

The objective of survival analysis may be just to describe the lifetimes of a single population or to compare the differences in survival times between two or more groups. Survival data have two important features that differ from other conventional statistical methods. These features are "censoring and time-dependent covariates (time-varying explanatory variables),"[112] To understand censoring, one must understand the events in the survival data. For survival analysis, the definition of events in the data is important. Events are generally defined as qualitative changes that can be situated in time.[113]

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[111] Paul D. Allison, *Survival Analysis Using SAS* (SAS Publishing, North Carolina, 2003), 1.

[112] Ibid.

[113] Qualitative changes are transitions from one discrete state to another. For example, promotion is a qualitative change.

In survival data, typically some subjects have censored survival types which mean that the survival times of some subjects are not observed because the events did not take place for this subject before termination of the study. Figure 5 shows censoring types.

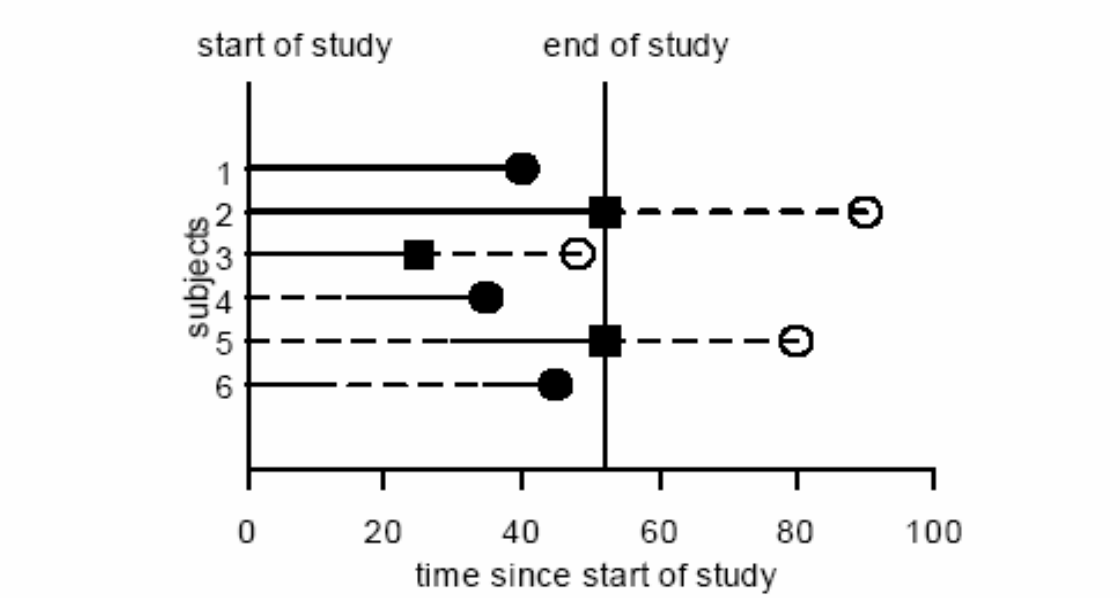

Figure 5. Censoring Types in the Survival Data. (From: John Fox, Survival Analysis Notes).[114]

Subject 1, uncensored; 2, fixed-right censoring; 3, random-right censoring; 4 and 5, late entry; 6, multiple intervals of observation.

Subject 1 is uncensored because he/she entered the study at the beginning and left before the end of the study. Subject 2 is enrolled in the study from the beginning and continued on after the end of the study. This is an example of fixed-right censoring. Subject 3 is enrolled at the beginning of the study but lost contact with the study before the end of the study. This is an example of random-right censoring. Subject 4 is enrolled in the study some time after the study began and left before the end of the study. This is an example of uncensored late entry and also it is an example of left censoring. Subject 5 is an example of observed late entry. Subject 6 is enrolled in the study at the beginning and lost contact after some time and then regained contact. This is an example of multiple

[114] John Fox, Introduction to Survival Analysis, Sociology 761 Lecture Notes, McMaster University, Ontario, Canada, Fall 2004, 1.

intervals of observation.[115] In the case of censoring, the important part is combining the information in the censored and uncensored cases in a way that produces consistent estimates.

Besides censoring, understanding the probability distributions of the survival data is important. There are three ways of describing probability functions. One is the Cumulative Distribution Function or c.d.f.. The c.d.f. of a variable T, (F (t)), is a function that gives the probability that the variable will be less than or equal to any value t that is chosen. Thus, $F(t)=\Pr\{T\leq t\}$. If the value of F is known for every value of t, then it is easy to understand the distribution of T.[116]

In survival analysis, the survivor function is important. It is defined as $S(t)=\Pr\{T>t\}=1-F(t)$. If the event is leaving the organization, the survivor function gives the probability of staying in the organization beyond t.[117] If the variables are continuous, the probability distribution can be defined as probability density function or p.d.f. This function is defined as:

$$f(t)=\frac{dF(t)}{dt}=-\frac{dS(t)}{dt}.$$

As seen from the equation, the p.d.f. is just a derivative or slope of the c.d.f. The hazard function is actually more popular than the p.d.f. in describing distributions. The hazard function is defined as:

$$h(t)=\lim_{\Delta t\to 0}\frac{\Pr\{t\leq t+\Delta t \setminus T\geq t\}}{\Delta t}.$$

The hazard cannot be negative, but it can be larger than 1. The hazard is interpretable as the expected number of events per individual per unit of time. The aim of the definition is to quantify the instantaneous risk that an event will occur at time t. The survivor function and hazard function are estimated from the observed survival times.

115 John Fox, Introduction to Survival Analysis, Sociology 761 Lecture Notes, McMaster University, Ontario, Canada, Fall 2004, 1.

116 Paul D. Allison, *Survival Analysis Using SAS* (SAS Publishing, North Carolina, 2003), 1.

117 Ibid.

The survivor function, the probability density function, and the hazard function are equivalent ways of describing a continuous probability distribution.[118] Each function can be derived from the other:

$$h(t) = \frac{f(t)}{S(t)} \ .$$

There are many approaches to survival analysis such as life tables, Kaplan-Meier estimators, exponential regression, log-normal regression, proportional hazards regression, competing risks model and discrete-time methods. All these methods may produce the same or different results and sometimes may be complementary. The aim of the study is important at this point. If the aim is to estimate lifetime distributions, the SAS procedure, LIFETEST will be suitable. If the aim is to predict survival times, then non-parametric methods such as life tables, Kaplan-Meier estimators or parametric methods such as exponential, Weibull estimators are more suitable.[119] In this thesis, the LIFETEST, LIFEREG, and PHREG procedures of SAS software are used for survival analysis. A brief overview of each of them follows.[120]

LIFETEST is designed for univariate analysis of the timing of events. It produces life tables and graphs of survival curves and tests whether survival curves are the same in two or more groups. It also tests for associations between event times and time-constant covariates. A weakness of LIFETEST is that it does not produce estimates of parameters. LIFEREG estimates regression models with censored, continuous-time data under different distributional assumptions. It uses censored data, but a weakness is that it does not allow for time-dependent covariates. PHREG uses Cox's partial likelihood method to estimate regression models with censored data. It allows for time dependent covariates and handles both continuous-time and discrete-time data.

The data structure for the LIFETEST, LIFEREG, and PHREG procedures should be same. For each case in the sample, there must be one variable that contains the time for which censored cases is the difference of the last time observed and the origin time of

[118] Paul D. Allison, *Survival Analysis Using SAS* (SAS Publishing, North Carolina, 2003), 1.

[119] Nick Fieller, *Medical Statistics: Survival Analysis, Course Notes*, University of Sheffield, 2002.

[120] Paul D. Allison, *Survival Analysis Using SAS* (SAS Publishing, North Carolina, 2003), 1

the experiment and for uncensored cases it is the difference between the time that the event occurred and the origin time of the experiment. In this study, this variable is SERVTIME, which indicates the months served in the Navy by each Naval officer. Also, a second variable is necessary, which indicates the status of the individual at the time recorded in the first variable. In this study, this variable is SEPARATE, which indicates whether the Naval officer is separated from the service or not. For the LIFEREG, and PHREG procedures the record should also contain values of the covariates.[121] The second part of this chapter explains the LIFETEST, LIFEREG, and PHREG procedures in more detail.

2. PROC LIFETEST Procedure

Before the 1970s, estimating survival curves was the dominant method for survival analysis. After Cox proposed the Proportional Hazard Regression model, they lost their dominance. However, they are still very useful in explanatory data analysis, especially for preliminary examination of the data, for computing derived quantities from regression models and for evaluating the fit of regression models.[122]

PROC LIFETEST uses two methods for estimating survivor functions. The Kaplan-Meier method is the most famous technique. Also, it is the most suitable method for smaller data sets with accurately measured event times. The life-table or actuarial method is better for large data sets with roughly measured event times. PROC LIFETEST also tests the null hypothesis that the survivor functions are identical for two or more groups. Also, it can test the associations between survival time and sets of quantitative covariates.[123] Since the PROC LIFETEST is examined more extensively in the following chapters, the explanation is restricted at this point.

3. PROC LIFEREG Procedure

The PROC LIFEREG procedure uses the maximum likelihood method for producing estimates of parametric regression models with censored survival data. The popularity of PROC PHREG has made the use of PROC LIFEREG almost disappear from the literature. However, PROC LIFEREG is still better at some things than PROC

[121] Paul D. Allison, *Survival Analysis Using SAS* (SAS Publishing, North Carolina, 2003), 29.

[122] Ibid.

[123] Ibid.

PHREG. PROC LIFEREG provides accommodation for left censoring and interval censoring, while PROC PHREG only allows right censoring. Also, PROC LIFEREG can test certain hypothesis about the shape of the hazard function while PROC PHREG only gives the nonparametric estimates of the survivor function. When knowledge about the survival distribution is available, PROC LIFEREG is better for estimation.[124] The weakest feature of the PROC LIFEREG is that it does not allow for the use of time-dependent covariates, while PROC PHREG does. PROC LIFEREG allows the use of Weibull, exponential, gamma, log-logistic, and log-normal distributions in the survival analysis.[125]

4. PHROC PHREG Procedure

David Cox proposed the Cox Regression model, known as the semi-parametric model, in 1972. Since then, it has become very popular.[126] The PROC PHREG procedure combines the Proportional Hazards Model and the maximum partial likelihood method.

The biggest advantage of the PROC PHREG procedure is that it can represent survival times without the need to choose some particular probability distribution. As a result of this feature, it is called semi-parametric. The second biggest advantage is that it allows the use of time-dependent covariates, which may change their values during the observation time. Other advantageous features of the Cox regression are that it allows stratified analysis, can accommodate both continuous and discrete measurement of event times, easily handles left truncation and can be extended to nonproportional hazards. The main disadvantage of the Cox Regression is that it cannot test hypotheses about the shape of the hazard function.[127]

C. MODEL SPECIFICATION

The model developed for this study combines many insights from the literature. In particular, it draws on Bowman and Mehay (2002) and Mehay and Bernard (2003) in the choice of the variables to be included. In survival analysis, the survivor function and

[124] Paul D. Allison, *Survival Analysis Using SAS* (SAS Publishing, North Carolina, 2003), 29.

[125] Ibid.

[126] David Cox, *"Regression Models and Life Tables," Journal of the Royal Statistical Society,* Series B, (1973): 187-220.

[127] Paul D. Allison, *Survival Analysis Using SAS* (SAS Publishing, North Carolina, 2003), 29.

hazard function are estimated from the observed survival times. If the event is leaving the organization, the survivor function is defined as the probability of staying in the organization beyond t. The hazard is interpretable as the expected number of events per individual per unit of time. The aim of the definition is to quantify the instantaneous risk that an event will occur at time t. The hazard cannot be negative but, it can be larger than 1.

In this thesis, the survivor function for Naval officers is the probability of staying in the Navy beyond the year 2000, which is the year that the data were last updated or the last date at which officers were observed. The hazard for an officer is the instantaneous risk that the officer will leave the Navy at a particular time.

The hazard for an officer *i*, or $h_i(t)$, can be represented as:

$$h_i(t) = \lambda_0(t) \times \exp(\ f(\text{Commissioning Age, Gender, Race, Marital Status, Commissioning Source, Prior Enlisted Experience, College Selectivity, Undergraduate GPA, Technical Major, Graduate Education, Designator, Commissioning Year})),$$

where $\lambda_0(t)$ is the baseline function.

The hypothesis tested is that the length of service time is the same for officers commissioned through different commissioning sources.

That is:

H_O= The length of the service time for officers commissioned from a particular commissioning source is same as the length of the service time for other commissioning sources, ceteris paribus.

H_1= The length of the service time for officers commissioned from a particular commissioning source is not same as the length of the service time for other commissioning sources, ceteris paribus.

D. VARIABLE DESCRIPTION

Model specification is based on literature, and the choice of explanatory variables specifically is based on Bowman and Mehay (2002) and Mehay and Bernard (2003). Table 1 shows the variables used in this thesis. The dependent variable is SERVTIME,

which accounts for the months a Naval officer served in the Navy. The variable SERVTIME is created from the variables SEPYR (the year of separation from service), SEPMO (the month of the year separated from service), YRCOMM (commissioning year), and MOCOMM (month of the commissioning year). The censoring variable is SEPARATE. It shows whether or not an officer is separated from the Navy. Independent variables are grouped into the following categories: Demographic variables, commissioning sources, community designators, career characteristics, human capital variables, and control variables. Table 11 lists each variable.

1. Demographic Variables

AGECOMM is a continuous variable that reflects an officer's age at the time of commissioning. Officers with higher ages at commissioning time may be considered more experienced and more productive. Increased productivity would indicate higher levels of professional success than less productive officers. Higher levels of success would likely lead to more satisfaction with the job and longer service time than for officers commissioned when younger.

The variables WHITE, BLACK, HISP and OTHER are all dummy variables indicating the race or ethnicity of the officers. The literature shows that ethnicity affects the retention and service time of officers. Minorities tend to stay in the service longer than white officers, the base case. The variable FEMALE and MALE are binary variables that reflect an officer's gender. The base case is MALE. In most of the literature, females were likely to have shorter length of service because they are more likely to experience interrupted careers, mostly because of family responsibilities.

SNC, SWC, MNC, and MWC are all binary variables that reflect whether an officer is married or single and if the officer has dependents. SNC corresponds to single officers with no children, SWC reflects single officers with children, MNC reflects married officers that have no children, and MWC reflects married officers that have at least one child. The base case is SNC. Past studies showed that married officers tend to have more service time in the service.

2. Commissioning Source

Variables were constructed to group officers into five different commissioning categories. These are USNA, ROTC Scholarship, ROTC Contract, OCS, and OTHERSOURCE. Bowman and Mehay (2002)[128], and Parcell (2001)[129], found that USNA graduates were likely to have longer service time than officers from other commissioning sources due to the long and intense military training at USNA. The base case is USNA.

3. Community Designators

SWO, SUB, AIR, SPEC, FSP, SCOR, MED and RLS variables show the community designators of the officers. The base case is RLS. Past research has shown that aviators are likely to stay longer than officers from other communities.[130] The longer obligation time and Aviation Continuation Pay directly affect the length of service time of Aviation officers. This thesis expects the same results.

4. Career Characteristics

SOMEPRIOR is another binary variable that reflects whether or not an officer completed any active enlisted service prior to being commissioned. Previous studies have shown that officers with prior service are likely to have more service time.[131] Their enlisted experience affects their job performance and their retention decisions positively. The author expects that prior enlisted officers are likely to stay longer than officers without prior enlisted experience.

5. Human Capital Indicators

The two variables constructed for college selectivity (SELCOLL, NONSELCOLL) reflect the selectivity of an officer's undergraduate college, as ranked by Barron's publication. The base case is NONSELCOLL. Officers who graduated from highly selective colleges are less likely to stay in the Navy because of the high probability of finding a job in the civilian market.

128 W. R. Bowman, and S. L. Mehay, College Quality and Employee Job Performance: Evidence from Naval Officers, Labor and Relations Review, 2002.

129 Ann D. Parcell, Optimizing Officer Accession Sources, Center for Naval Analyses, 2 October 2001.

130 William R. Bowman, *Cost Effectiveness of Service Academies: New Evidence from Navy Warfare Communities,* (Annapolis, Maryland:U.S. Naval Academy, June 1995).

131 Joel P Bernard, and Stephen L. Mehay, An Analysis of Alternate Accession Sources for Naval Officers, (Monterey, California: Naval Postgraduate School, May 2003).

The NAPC variable shows undergraduate academic performance. Officers with high NAPC, which means high undergraduate GPA, are more likely to have better job performance, and as a result, are more likely to have longer service time in the Navy.

TECHMAJ shows the officer's academic background. Bowman and Mehay (2002) found that officers with technical undergraduate degrees were more likely to promote to O-4 than those with humanities degrees.[132] Due to the increasing technical complexity of the jobs in the Navy, it is believed that having a technical degree increases an officer's performance and promotion opportunity. Thus, officers with technical degrees are more likely to stay in the service.

The variable GRADEDU shows whether the officer has a graduate education. Graduate education has positive and negative effects on the length of service time of the Navy officers. Graduate education increases the obligation time and job performance and promotion possibilities of the officers. This is the positive effect. On the contrary, graduate education increases the job finding possibilities of the officers in the labor market. This makes a negative effect on the length of service time of officers.

6. Control Variables

To control other non-measurable factors, for example, differences in promotion opportunities from year to year and effects of drawdown, a series of year group dummy variables were constructed and included (YRG83-YRG90) to indicate the fiscal year.

Table 11. Variable List.

VARIABLE	DESCRIPTION	TYPE
Dependent Variable		
SERVTIME	MONTHS SERVED BEFORE LEAVING THE SERVICE	INTERVAL
Censoring Variable		
SEPARATE	=1 IF SEPARATED FROM SERVICE VOLUNTARILY; =2 IF SEPARATED FROM SERVICE INVOLUNTARILY; =0 IF STILL IN SERVICE	ORDINAL
Independent Variables		
Demographics		
AGE_COMM	AGE AT COMMISSIONING (IN YEARS)	INTERVAL
WHITE	= 1 IF RACE IS WHITE; = 0 OTHERWISE (BASE CASE)	BINARY
BLACK	= 1 IF RACE IS BLACK; = 0 OTHERWISE	BINARY
HISP	= 1 IF RACE IS HISPANIC; = 0 OTHERWISE	BINARY

[132] W. R. Bowman and S. L. Mehay, College Quality and Employee Job Performance: Evidence From Naval Officer, *Labor and Relations Review,* 2002.

VARIABLE	DESCRIPTION	TYPE
OTHER	= 1 IF RACE IS NOT WHITE OR BLACK OR HISP; = 0 OTHERWISE	BINARY
FEMALE	= 1 IF GENDER IS FEMALE; = 0 OTHERWISE	BINARY
MALE	= 1 IF GENDER IS MALE; = 0 OTHERWISE (BASE CASE)	BINARY
SNC	= 1 IF SINGLE WITH NO CHILDREN; = 0 OTHERWISE (BASE CASE)	BINARY
SWC	= 1 IF SINGLE WITH CHILDREN; = 0 OTHERWISE	BINARY
MNC	= 1 IF MARRIED WITH NO CHILDREN; =0 OTHERWISE	BINARY
MWC	= 1 IF MARRIED WITH CHILDREN; = 0 OTHERWISE	BINARY
Commissioning Sources		
USNA	= 1 IF ACCESSION SOURCE IS USNA; = 0 OTHERWISE (BASE CASE)	BINARY
ROTCSK	= 1 IF ACCESSION SOURCE IS ROTC SCHOLARSHIP; = 0 OTHERWISE	BINARY
ROTCC	= 1 IF ACCESSION SOURCE IS ROTC CONTRACT; = 0 OTHERWISE	BINARY
OCS	= 1 IF ACCESSION SOURCE IS OCS; = 0 OTHERWISE	BINARY
OTHERSOURCE	= 1 IF ACCESSION SOURCE IS NOT USNA OR ROTCSK OR ROTCC OR OCS ; =0 OTHERWISE	BINARY
Community Designators		
SWO	= 1 IF SURFACE WARFARE OFFICER; = 0 OTHERWISE	BINARY
SUB	= 1 IF SUBMARINE OFFICER; = 0 OTHERWISE	BINARY
AIR	= 1 IF PILOT OR NFO; = 0 OTHERWISE	BINARY
SPEC	= 1 IF SPECIAL WARFARE OR SPECIAL OPERATIONS OFFICER; = 0 OTHERWISE	BINARY
FSP	= 1 IF FLEET SUPPORT OFFICER; = 0 OTHERWISE	BINARY
SCOR	= 1 IF SUPPLY CORPS OFFICER; = 0 OTHERWISE	BINARY
MED	= 1 IF MEDICAL OFFICER; = 0 OTHERWISE	BINARY
RLS	= 1 IF OTHER RESTRICTED LINE OR STAFF OFFICER; = 0 OTHERWISE (BASE CASE)	BINARY
Career Characteristics		
SOMEPRIOR	= 1 IF PRIOR ENLISTED; = 0 OTHERWISE	BINARY
Human Capital Variables		
SELCOLL	= 1 IF COLLEGE ATTENDED IS HIGHLY SELECTIVE; = 0 OTHERWISE	BINARY
NONSELCOLL	= 1 IF COLLEGE ATTENDED IS SELECTIVE; = 0 OTHERWISE (BASE CASE)	BINARY
NAPC	= 0-5 ACADEMIC PROFILE CODE (UNDERGRADUATE GPA)	ORDINAL
TECHMAJ	= 1 IF UNDERGRADUATE MAJOR IS TECHNICAL; = 0 OTHERWISE	BINARY
GRADEDU	= 1 IF ATTENDED TO A GRADUATE EDUCATION; = 0 OTHERWISE	BINARY
Control Variables		
YRG83	= 1 IF ACCESSED IN YEAR GROUP 1983; = 0 OTHERWISE	BINARY
YRG84	= 1 IF ACCESSED IN YEAR GROUP 1984; = 0 OTHERWISE	BINARY
YRG85	= 1 IF ACCESSED IN YEAR GROUP 1985; = 0 OTHERWISE	BINARY
YRG86	= 1 IF ACCESSED IN YEAR GROUP 1986; = 0 OTHERWISE	BINARY
YRG87	= 1 IF ACCESSED IN YEAR GROUP 1987; = 0 OTHERWISE	BINARY
YRG88	= 1 IF ACCESSED IN YEAR GROUP 1988; = 0 OTHERWISE	BINARY
YRG89	= 1 IF ACCESSED IN YEAR GROUP 1989; = 0 OTHERWISE	BINARY
YRG90	= 1 IF ACCESSED IN YEAR GROUP 1990; = 0 OTHERWISE	BINARY

Table 12 shows the number, mean, standard deviation, minimum and maximum of each variable.

Table 12. Means Procedure

VARIABLE	N	MEAN	STD. DEV.	MIN.	MAX.
SEPARATE1	34960	0.896596	0.671623	0	2
SERVTIME	34960	108.4642	47.79585	12	213
AGECOMM	34960	23.47463	2.655424	20	35
BLACK	34960	0.048312	0.214429	0	1
HISP	34960	0.019422	0.138006	0	1
OTHER	34960	0.020795	0.1427	0	1
FEMALE	34960	0.124199	0.329813	0	1
SNC	34955	0.530854	0.499054	0	1
SWC	34955	0.009841	0.098715	0	1
MNC	34955	0.033929	0.18105	0	1
MWC	34955	0.425261	0.49439	0	1
TECHMAJ	34960	0.530463	0.499078	0	1
ROTCSK	34960	0.26845	0.443159	0	1
USNA	34960	0.196281	0.39719	0	1
ROTCC	34960	0.031207	0.173879	0	1
OCS	34960	0.369422	0.482655	0	1
OTHERSOURCE	34960	0.13464	0.341343	0	1
TOPCOLL	31172	0.157641	0.36441	0	1
NONSELCOLL	31172	0.622225	0.484838	0	1
NAPC	27326	1.993998	0.990366	0	5
SWO	34960	0.271854	0.444921	0	1
AIR	34960	0.323284	0.467737	0	1
SUB	34960	0.10901	0.311657	0	1
FSP	34960	0.053976	0.225974	0	1
SCOR	34960	0.062529	0.242117	0	1
MED	34960	0.084668	0.278391	0	1
RLS	34960	0.078919	0.269616	0	1
GRADEDU	34960	0.026316	0.160075	0	1
YRG83	34960	0.12869	0.334861	0	1
YRG84	34960	0.109382	0.312123	0	1
YRG85	34960	0.141619	0.348664	0	1
YRG86	34960	0.14488	0.351985	0	1
YRG87	34960	0.126344	0.332242	0	1
YRG88	34960	0.127088	0.333076	0	1
YRG89	34960	0.131064	0.337475	0	1
YRG90	34960	0.090932	0.287517	0	1

Table 13 shows the hypothesized effects of the variables in the model on the longevity of an officer. The base case is a white, male, unmarried Navy officer, who was graduated from a non-selective college, was commissioned through USNA and was designated in the RLS community.

Based on previous studies, it is expected that officers who are older at commissioning time will remain in the Navy longer than officers commissioned at younger ages. This is expected because of the transfer of experience gained before

commissioning. Officers commissioned at older ages can transfer their experience to the military, and in this way, they can improve their job performance and stay longer as a result of increased promotion possibilities resulting from improved performance.

Additionally, officers who belong to a minority race or ethnic groups are expected to have longer service time according to earlier studies. This is anticipated as the result of more limited job opportunities for minorities in the civilian labor market. Also, it has been observed that married officers tend to have longer service time compared to the unmarried officers. This may be because of increased fiscal responsibility of being married. Female officers tend to have shorter service time than male officers.[133] This may be result of interrupted careers of female officers, pregnancy, or other family issues.

The only commissioning source that is expected to have a positive effect on the length of officers' service time is the USNA according to the result of previous studies. This may be related to the longer military training received at the USNA. In designator communities, aviation officers are expected to have longer service time than other designator communities because of their longer obligation time and increased retention caused by Aviation Continuation Pay.

Officers with prior enlisted experience are expected to have longer service time than their counterparts, based on the results of the previous studies as a result of transferring their enlisted experience to their officer careers. Consequently, they are expected to have improved job performance, better promotion opportunities and longer service lengths. Also, usually prior enlisted officers have already adapted. This is also expected to increase their service length. Officers graduated from highly selective colleges tend to leave the military early because of better job opportunities in the civilian job market. Past research has shown that officers with high undergraduate GPAs and technical majors are expected to have longer service time lengths because of improved job performance and promotion opportunities related to the increased technical complexity in the Navy.

[133] Joel P Bernard, and Stephen L. Mehay, An Analysis of Alternate Accession Sources for Naval Officers. (Monterey, California: Naval Postgraduate School, May 2003).

Graduate education is expected to have both positive and negative effects on the service length of officers. The positive effect is related to improved job performance and increased obligation time. Also, graduate education increases the credibility of officers in the civilian job market and will have a negative effect on the service length of officers. Previous research showed that the positive effect was dominant. Thus, graduate education is expected to increase the length of service time of officers.

Table 13. Variable Hypothesized Effects.

VARIABLE	HYPOTHESIZED EFFECT
Demographics	
AGE_COMM	+
WHITE	Base
BLACK	+
HISP	+
OTHER	+
FEMALE	-
MALE	Base
SNC	Base
SWC	+
MNC	+
MWC	+
Commissioning Sources	
USNA	Base
ROTCSK	-
ROTCC	-
OCS	-
OTHERSOURCE	-
Community Designators	
SWO	-
SUB	-
AIR	+
SPEC	-
FSP	-
SCOR	-
MED	-
RLS	Base
Career Characteristics	
SOMEPRIOR	+
Human Capital Variables	
SELCOLL	+
NONSELCOLL	Base
NAPC1	+
TECHMAJ	+
GRADEDU	+
Control Variables	
YRG83	?

VARIABLE	HYPOTHESIZED EFFECT
YRG84	?
YRG85	?
YRG86	?
YRG87	?
YRG88	?
YRG89	?
YRG90	?

E. DATA

Data used in this study were provided by Prof. William R. Bowman, Economics Department, U.S. Naval Academy. The same data were examined by Joel Bernard for his thesis, "An Analysis of Alternate Accession Sources for Naval Officers" at the Naval Postgraduate School, Monterey, California, March 2002. The data contain Navy Officer Data Card Information for officers commissioned through 1983 to 1990. Prof. Bowman merged the Data Card files with O-3 (LT) and O-4 (LCDR) promotion board results for fiscal years 1986 through 2001 by social security number. The data set was checked to determine whether officers left the service before the LT and LCDR points. Also, Prof. Bowman added some additional variables that show the highest rank of the officers. Overall, the data set contains information on 753 variables for 34,991 Naval Officers commissioned from 1983 to 1990.

In the data file, the commissioning sources for officers are: U.S. Naval Academy, Navy Reserve Officer Training Corps Scholarship Program (NROTCSK), Navy Reserve Officer Training Corps Contract Program (NROTCC), Officer Candidate School (OCS), and other sources (OTHER), which are mainly lateral transfers, Enlisted to Officer Programs and Direct Appointments. Figure 6 presents the total number and percentage of the Naval officers by commissioning source. OCS graduates are the largest group, accounting for 37% of the total. The total number of the OCS graduates is 12,915. The second largest group is NROTC Scholarship graduates, who account for 27% of the total. Their number is 9,385. USNA and OTHER sources accounted for 20% and 13%, respectively, numbering 6,862 and 4,707. The smallest group is NROTC Contract graduates who account for only 3% of the total numbering 1,091.

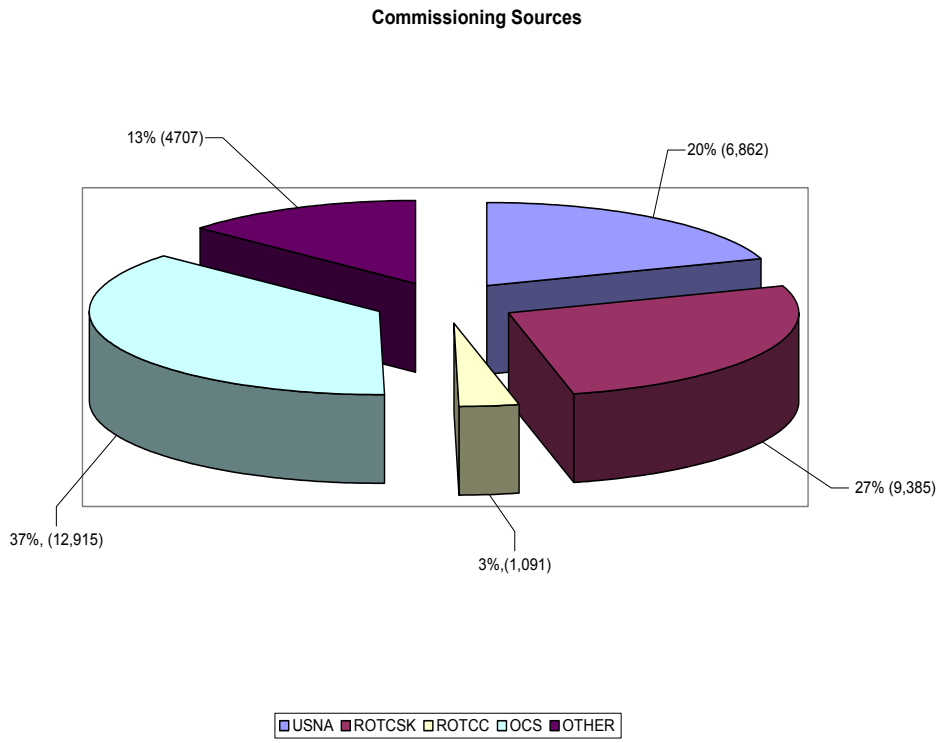

Figure 6. Percentages of Naval Officers by Commissioning Sources, 1983-1990 Cohorts.

The number of officers from each commissioning source by commissioning year can be seen in Figure 7. Since Congress mandates how many midshipmen may attend USNA, there are no great differences between years for the USNA graduates. The annual average is 857 USNA graduates over the eight years.

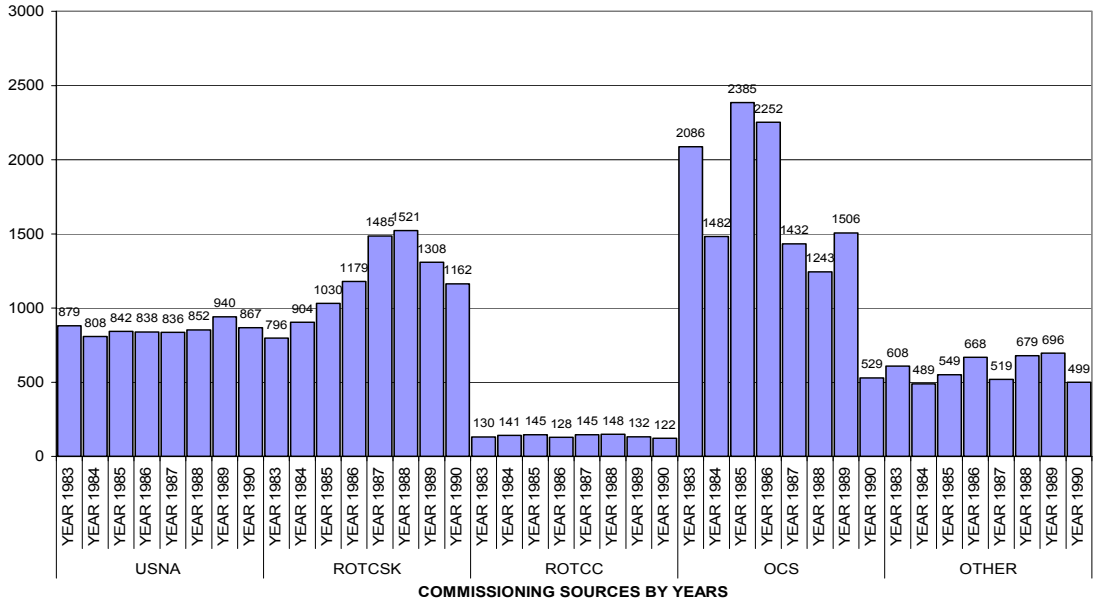

Figure 7. Naval Officers Commissioning Sources by Year

As can be seen from Table 14 and Figure 8, OCS provided the primary means to cover personnel shortfalls during this period, which caused big fluctuations in the number of officers commissioned each year from this source.

Table 14. Percentages from Commissioning Sources by Year.

	COMMISSIONING SOURCE					
COMM.YEAR	**USNA**	**ROTCSK**	**ROTCC**	**OCS**	**OTHER**	**TOTAL**
1983	19.54%	17.69%	2.89%	46.37%	13.51%	100.00%
1984	21.13%	23.64%	3.69%	38.76%	12.79%	100.01%
1985	17.01%	20.80%	2.93%	48.17%	11.09%	100.00%
1986	16.54%	23.28%	2.53%	44.46%	13.19%	100.00%
1987	18.93%	33.62%	3.28%	32.42%	11.75%	100.00%
1988	19.18%	34.23%	3.33%	27.98%	15.28%	100.00%
1989	20.52%	28.55%	2.88%	32.87%	15.19%	100.01%
1990	27.27%	36.55%	3.84%	16.64%	15.70%	100.00%

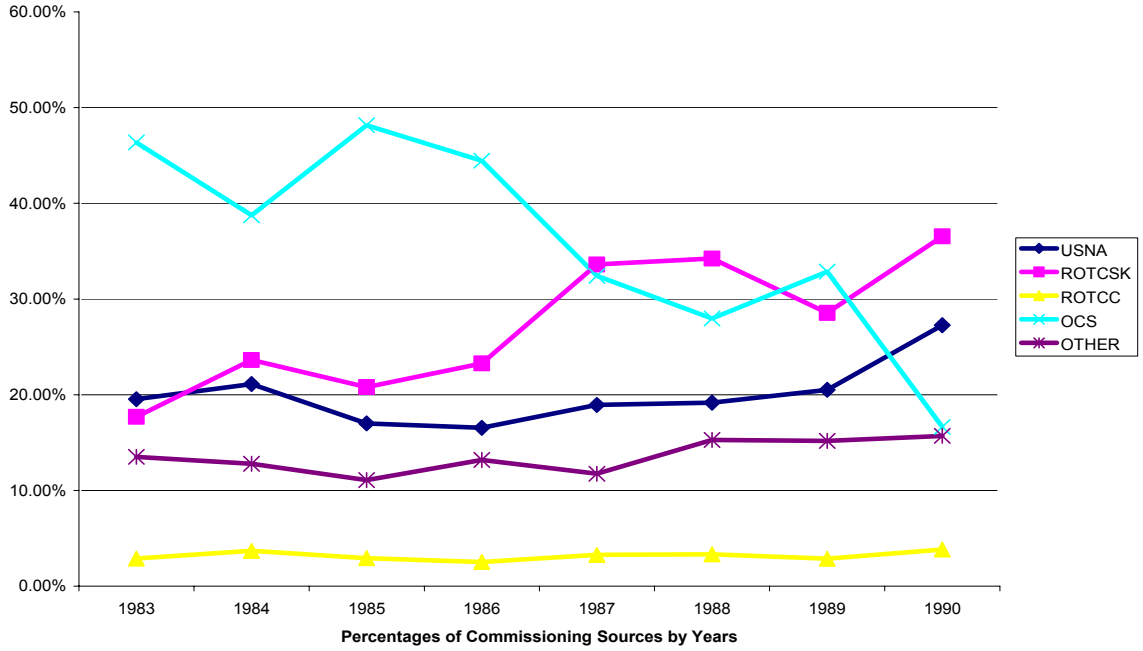

Figure 8. The Percentages of Commissioning Sources by Years.

Figure 9 shows the number and percentage of male and female officers in all the cohorts from 1983 to 1990. Female officers accounted for 12% of all Naval commissioned officers over the entire period.

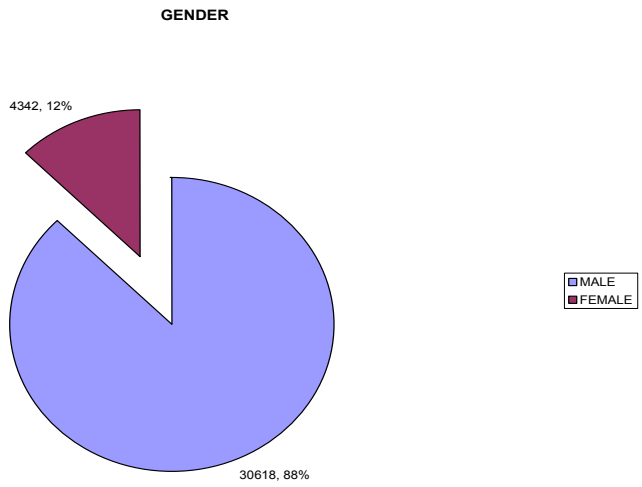

Figure 9. The Percentage of Male and Female Naval Officers 1983-1990 Cohorts.

The difference in length of commissioned service by gender for separated officers is detailed in Table 15. The length of service of females is about six months less than males on average. Among males, officers commissioned by OTHERSOURCE have the longest service time, while ROTCC graduates have the longest service time among female officers. The practical significance and effect of censored data is unknown, but the figures show that female officers tend to stay for a shorter time compared to male officers.

Table 15. Length of Commissioned Service by Gender for Separated Officers.

	N	MEAN
MALE	22062	86.72
FEMALE	3030	80.93

		N	AVERAGE
MALE	USNA	4356	90
	ROTCSK	6683	82.39
	ROTCC	633	86.56
	OCS	8662	87.38
	OTHER	1728	91.95
FEMALE	USNA	384	85.45
	ROTCSK	412	85.21
	ROTCC	114	98.13
	OCS	654	89.89
	OTHER	1466	73.21

Figure 10 shows the distribution of Naval officers by ethnicity for all cohort years. For all officers, Caucasians accounted for 91%, African-Americans for 5%, Hispanic officers for 2%, and other races, which are Asians, Native Americans and unknown originated officers account for the remaining 2%.

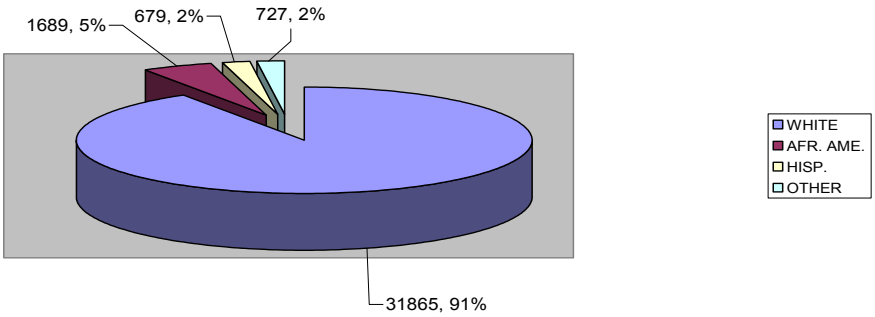

Figure 10. Naval Officers by Ethnicity, 1983-1990 Cohorts.

Table 16 shows the difference in length of commissioned service by ethnicity for separated officers. Black separated officers have a slightly longer service length than white separated officers while Asian, Philippines and Native American separated officers have about four months shorter and Hispanic officers is about one month shorter service length than separated white and black officers. The effect of censored data is unknown.

Table 16. Length of Commissioned Service by Ethnicity for Separated Officers in Months, 1983-1990 Cohorts.

	N	MEAN
WHITE	22980	86.12
BLACK.	1109	86.27
HISP	476	85.13
OTHER	527	82.05

		N	MEAN			N	MEAN
WHITE	USNA	4313	89.83	HISP	USNA	127	86.17
	ROTCSK	6688	82.75		ROTCSK	102	75.97
	ROTCC	673	88.04		ROTCC	7	71.71
	OCS	8499	87.84		OCS	175	86.46
	OTHER	2807	82.78		OTHER	65	95.35
BLACK	USNA	179	90.67	OTHER	USNA	121	84.67
	ROTCSK	205	81.46		ROTCSK	100	78.29

		N	MEAN			N	MEAN
	ROTCC	54	96.41		ROTCC	13	78.46
	OCS	463	86.1		OCS	179	79.15
	OTHER	208	84.99		OTHER	114	87.53

Figure 11 shows the distribution of the marital status of officers. Single Naval officers account for 54% of all Naval officers, compared to the 46% who were married officers.

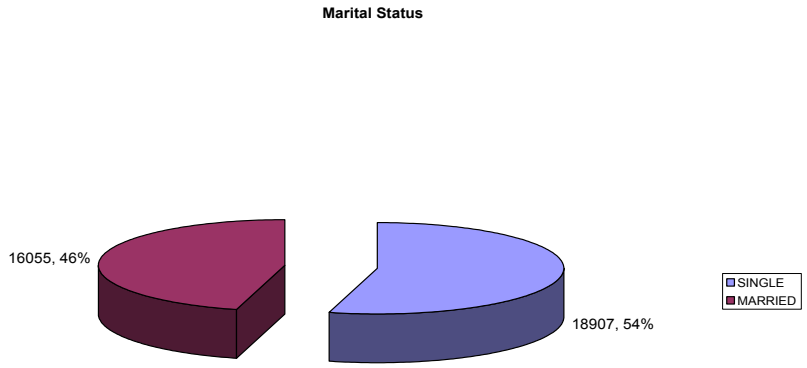

Figure 11. Marital Status of Naval Officers, 1983-1990 Cohorts.

Table 17 gives the length of commissioned service for married and single separated officers at entry. It can be observed that married officers appear to remain for more than five months longer than single officers. Also, married officers tend to remain longer in all commissioning sources. However, the effect of censored observations is unknown.

Table 17. Length of Commissioned Service in Months by Marital Status, Separated Officers, 1983-1990 Cohorts.

	N	MEAN
SINGLE	14177	83.51
MARRIED	10907	89.29

		N	MEAN
SINGLE	USNA	2759	89.24
	ROTCSK	4375	81.32
	ROTCC	448	87.58
	OCS	5069	84.41
	OTHER	1526	75.51
MARRIED	USNA	1981	90.17
	ROTCSK	2720	84.68
	ROTCC	299	89.44
	OCS	4245	91.32
	OTHER	1662	90.6

Figure 12 shows the numbers and percentages of Naval officers by designators. The Unrestricted Line (URL) officers account for 72% of Naval officers and the Restricted Line (RL) officers are 28% of all Naval officers. The AIR community is the largest officer community in the Navy with 11,302 officers, 34% of all officers. The second largest community is the Surface Warfare Officer (SWO) Community with 9,504 officers, 30% of the total. Submarine (SUB) officers number 3,811 and they represent 12% of all the officers in the Navy. Medical (MED), Restricted Line and Staff (RLS) officers, Supply Corps (SCOR) officers, Fleet Support (FSP) officers and Special Warfare or Special Operations (SPEC) officer communities follow SUB officers in number, respectively.

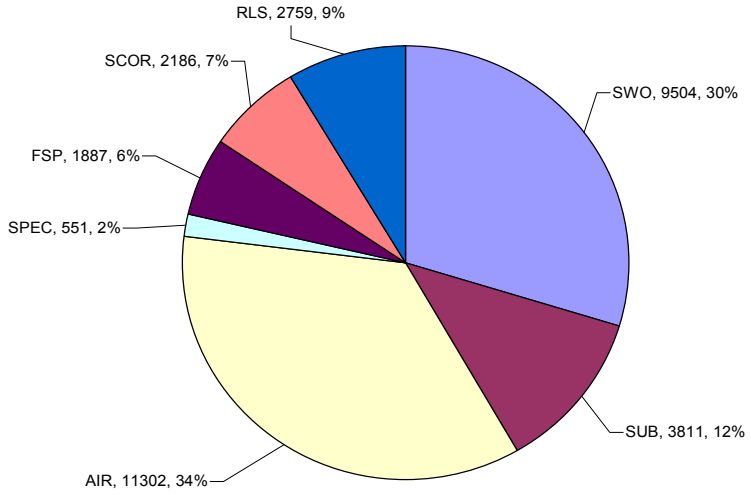

Figure 12. The Number and Percentages of Naval Officers by Designator, 1983-1990 Cohorts.

Table 18 shows the length of commissioned service by designator for separated officers. Air officers have the longest length of service among separated officers, followed by Special Warfare officers. Surface Warfare officers have the shortest length of service. The effect of censored data is unknown.

Table 18. Length of Commissioned Service in Months by Designator for Separated Officers, 1983-1990 Cohorts.

	N	MEAN
SWO	7380	75.11
SUB	2921	78.81
AIR	7857	101.99
SPEC	353	89.65
FSP	1371	78.97
SCOR	1498	81.98
MED	1896	82.4
RLS	1816	84.59

		N	MEAN			N	MEAN
SWO	USNA	1647	82.11	FSP	USNA	151	77.18
	ROTCSK	3180	69.87		ROTCSK	423	74.22
	ROTCC	330	75.21		ROTCC	91	94.86
	OCS	1986	73.99		OCS	408	90.06
	OTHER	237	106.22		OTHER	298	66.57
SUB	USNA	829	81.51	SCOR	USNA	274	77.94
	ROTCSK	837	80.26		ROTCSK	243	72.5
	ROTCC	6	94.33		ROTCC	15	75.4
	OCS	1178	74.47		OCS	940	85.32
	OTHER	71	101		OTHER	26	96.85
AIR	USNA	1504	106.5	MED	USNA	1	72
	ROTCSK	2077	106.1		ROTCSK	4	87
	ROTCC	265	102.62		ROTCC	1	129
	OCS	3883	97.83		OCS	9	105.22
	OTHER	128	106.75		OTHER	1881	82.26
SPEC	USNA	95	84.34	RLS	USNA	239	86.95
	ROTCSK	89	82.43		ROTCSK	242	79.65
	ROTCC	13	86.23		ROTCC	26	91.65
	OCS	142	95.25		OCS	770	90.54
	OTHER	14	117.86		OTHER	539	76.94

Figure 13 shows the number of the officers leaving the service in each year. The mean of the variable SERVTIME, which shows how many months an officer stays in the military service, is 108 months, or 9 years. The figure also shows that most of the officers stay in the service up to 4 or 5 years because of the obligatory service time. After that time, the number of the leavers decreases until the 10^{th} or 11^{th} year, which is typically after promotion to LCDR. An officer usually leaves the service, either after completing his or her obligation time or if he or she is not promoted to the LCDR rank. After that time, as can be seen from Figure 9, the number of leavers steadily decreases.

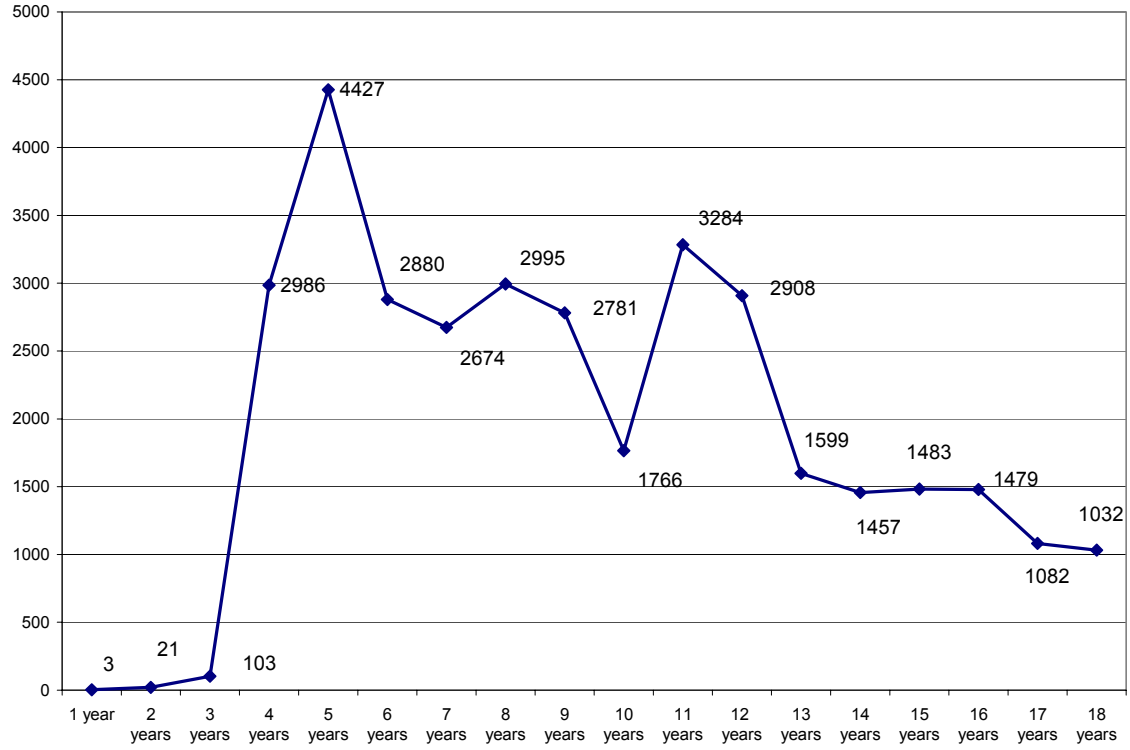

Figure 13. The Number of the Officers Separating by Years of Service.

F. DATA LIMITATIONS

Observations with missing critical data were removed from the sample. Specifically, 7,647 observations were deleted from the sample because of missing academic proficiency codes (APC). Since these are signs of academic and educational proficiency, they are likely to affect performance, retention, promotion and the career length of the officers in the service.

Also, the variable BARRONS has 3,793 missing values. Prof. Bowman created this variable from Barron's publication, "Profiles of American Colleges". In this publication, American Colleges are ranked on a scale of 1 to 6 with a ranking of 1 corresponding to "most selective". This variable was used to construct other variables that identify the effect of college quality on the longevity of the officers in the Navy.

The variable SOURCE, which indicates the commissioning source of the Naval officers has 42 missing values. The variable PRIDEP, which was used to construct the marital status and the number of dependent variables, had 5 missing values. The variable UGMAJORS has 4,232 missing values. UGMAJORS indicates the college majors of the

Naval officers. To identify officers with technical backgrounds, this variable was used to construct the variable TECHMAJ. Fifteen observations were deleted because of missing values related to the variable SEPARATE, which indicates the last observed condition in the data as to whether an officer is still in the Navy or has separated. Missing data decreased the reliability of the study.

V. RESULTS OF SURVIVAL ANALYSIS

A. OVERVIEW

The chapter analyzes the data described in previous chapters and presents the results of the survival analysis. The chapter is divided into four parts. The first three describe the survival procedures, LIFETEST, LIFEREG and PHREG, while the fourth analyzes voluntary and involuntary separations. In Chapter IV, fundamental survival analysis concepts and the basic functions of these procedures were explained. In this chapter, they are explained in more detail and applied to the data.

B. ESTIMATING AND COMPARING SURVIVAL CURVES WITH PROC LIFETEST

As mentioned in Chapter IV, PROC LIFETEST uses two methods for estimating survivor functions. These methods are Kaplan-Meier estimation and Life-table methods. PROC LIFETEST gives information about the shape of the survival function. Also, it can test whether the survival functions are identical for two or more groups. In addition, it can test the associations between survival time and sets of quantitative covariates.

Table 19 shows the results of the PROC LIFETEST procedure with the Kaplan-Meier estimator. Using this method, the career length of the 34,960 officers is examined. Of these, 9,879 are censored. The table demonstrates that the point estimate for the smallest event time, which means that the probability of leaving the service is greater than .25, is 64 months after commissioning. The point estimate for 75%, where the probability of leaving the service is greater than .75, is 189 months after commissioning.

Of greatest interest is the point estimate for 50%, which is the same time as the median service time. Here, the median is 102 months with a 95% confidence interval of 101 and 103 months. An estimated mean of service time, 119.382 months with 0.331 months standard error, is also reported with the results, but the median is usually a much preferred measure of central tendency for censored survival data.[134]

[134] Paul D. Allison, *Survival Analysis Using SAS* (SAS Publishing, North Carolina, 2003), 33.

Table 19. The LIFETEST Procedure Kaplan-Meier Summary Statistics For SERVTIME variable

%	POINT ESTIMATE	95% CONFIDENCE INTERVAL	
		LOWER	UPPER
75	189	185	196
50	102	101	103
25	64	63	64

The PROC LIFETEST procedure also can produce a graph of the estimated survivor function of the data. Figure 14 shows the survival function of Naval officers commissioned from years 1983 to 1990. As seen in the graph, the estimated survival function is horizontal up to 48-60 months because of the length of the initial obligated service after commissioning. After 120-130 months, it again becomes nearly flat compared to the interval between 60 and 120 months. This last effect is mostly related to promotion to the O-4 point.

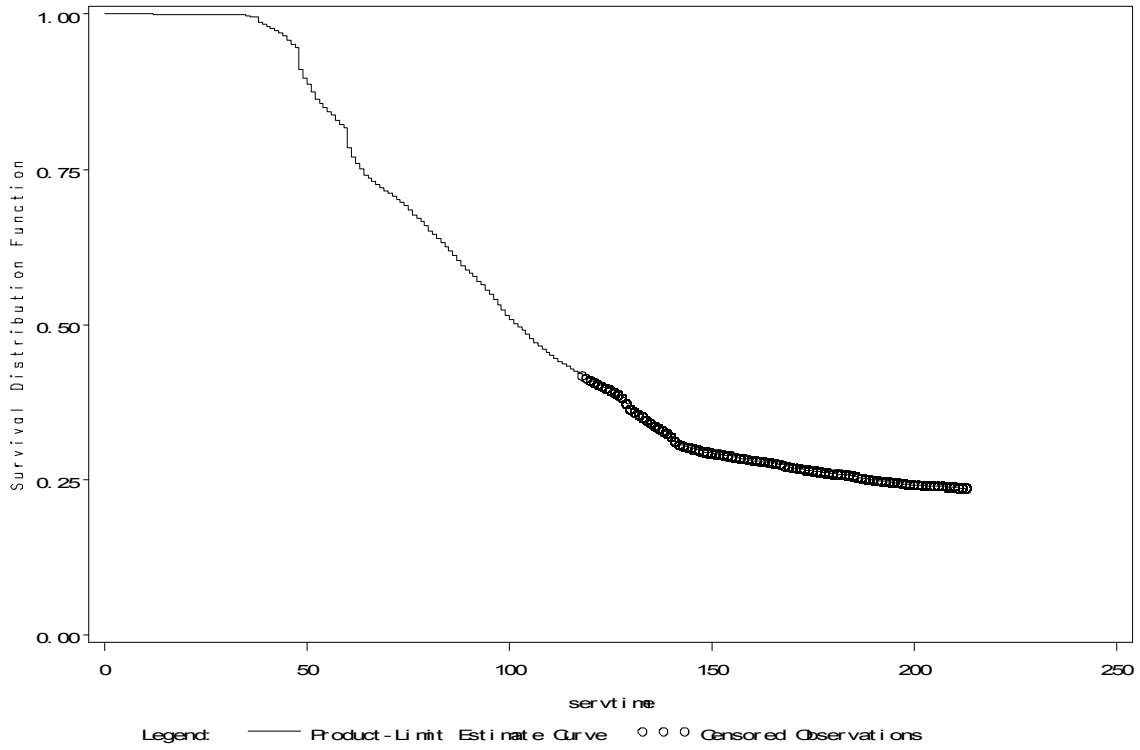

Figure 14. Graph of the Survival Function by LIFETEST Procedure.

The PROC LIFETEST can test whether the estimated survival functions are the same for different groups. The procedure uses the log-rank test and the Wilcoxon test. In this study, the SOURCE variable, which shows the commissioning sources, was tested for different estimated survival functions. The results show whether the estimated survival functions are the same for officers commissioned from different sources.

PROC LIFETEST gives log-rank and Wilcoxon statistics for each group, followed by an estimate of their sampling variances and covariances. These are used to compute the chi-square statistics.[135] Table 20 presents summary and rank statistics for the commissioning source groups.

[135] Paul D. Allison, *Survival Analysis Using SAS* (SAS Publishing, North Carolina, 2003), 33.

Table 20. Summary of the Number of the Observations and the Rank Statistics.

Source	Total	Failed	Censored	Log-Rank	Wilcoxon
USNA	6862	4740	2122	-505.38	-1.723E7
ROTCSK	9385	7094	2291	954.78	23817995
ROTCC	1091	747	344	-76.02	-1756157
OCS	12915	9315	3600	-161.06	-4383452
OTHER	4666	3158	1508	-212.32	-450325

Table 21 shows that the results of Log-Rank and Wilcoxon tests are highly significant (p-values of tests are <.0001) The null hypothesis of no difference among the five groups is rejected by all of the tests. The survival functions of groups of Naval officers commissioned from different sources are different.

Table 21. Testing Homogeneity of Survival Curves for Variable SOURCE.

Test	Chi-Square	DF	Pr >Chi-Square
Log-Rank	223.6830	4	<.0001
Wilcoxon	276.3435	4	<.0001
2Log(LR)	146.0052	4	<.0001

Also, Figure 15 shows the difference among survival functions for the commissioning sources. Figure 2 shows that for up to 48 months, the survival curves are identical because of the initial obligation. Between 48 and 60 months, USNA has the highest survival curve because USNA has an extra year of obligated time. USNA maintains this trend up to 80 months. Between 80 and 120 months, ROTCC has the highest survival curve. After 120 months, OTHER commissioning source becomes the source with highest curve up to 170 months. After 170 months, OCS and ROTCC become the sources with the highest survival curves. For all of the times, ROTCSK has the lowest survival curve among the commissioning sources.

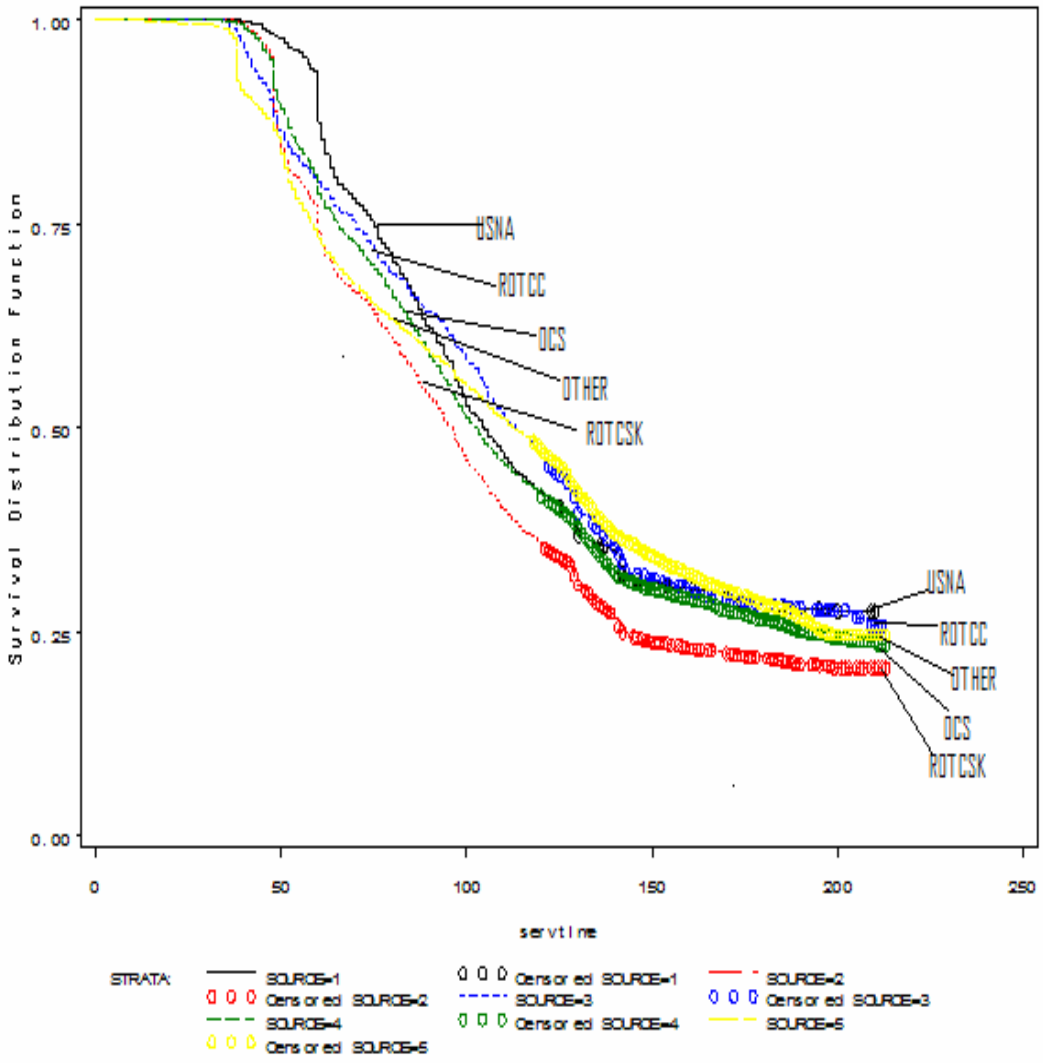

Figure 15. Plot of the Survival Function of the Variable SOURCE.

The variable DESIGNATOR was also tested for differences in estimated survival functions of the designator communities of Navy officers. Table 22 presents the summary and rank statistics of the groups of Naval officers from different designators.

Table 22. Summary of the Number of the Observations and the Rank Statistics.

Designator	Total	Failed	Censored	Log-Rank	Wilcoxon
SWO	9504	7380	2124	1828.0	59285428
SUB	3811	2920	891	539.9	14120432
AIR	11302	7857	3445	-1769.0	-7.049E7
SPEC	551	353	198	-83.6	-1817656
FSP	1887	1371	516	128.4	5394186
SCOR	2186	1498	688	-62.4	903746
MED	2960	1896	1064	-294.7	-2580984
RLS	2759	1806	953	-286.6	4817674

Table 23 shows the results of Log-Rank and Wilcoxon tests. The tests are all highly significant (p-values of tests are <.0001) and the null hypothesis is therefore rejected. The survival functions of Naval officers from different designators are different.

Table 23. Testing Homogeneity of Survival Curves for Variable DESIGNATOR

Test	Chi-Square	DF	Pr >Chi-Square
Log-Rank	1183.4202	7	<.0001
Wilcoxon	2312.1330	7	<.0001
-2Log(LR)	599.4697	7	<.0001

Figure 16 shows the survival functions of officer groups from different designators. The survival function of Aviators is the highest up to 100 months, most likely because of their longer initial obligation. After 100 months, the Special Warfare community has the highest survival function followed by Medical and other Restricted Line and Staff officers. Surface Warfare and Submarine officers show the lowest survival functions among the designators.

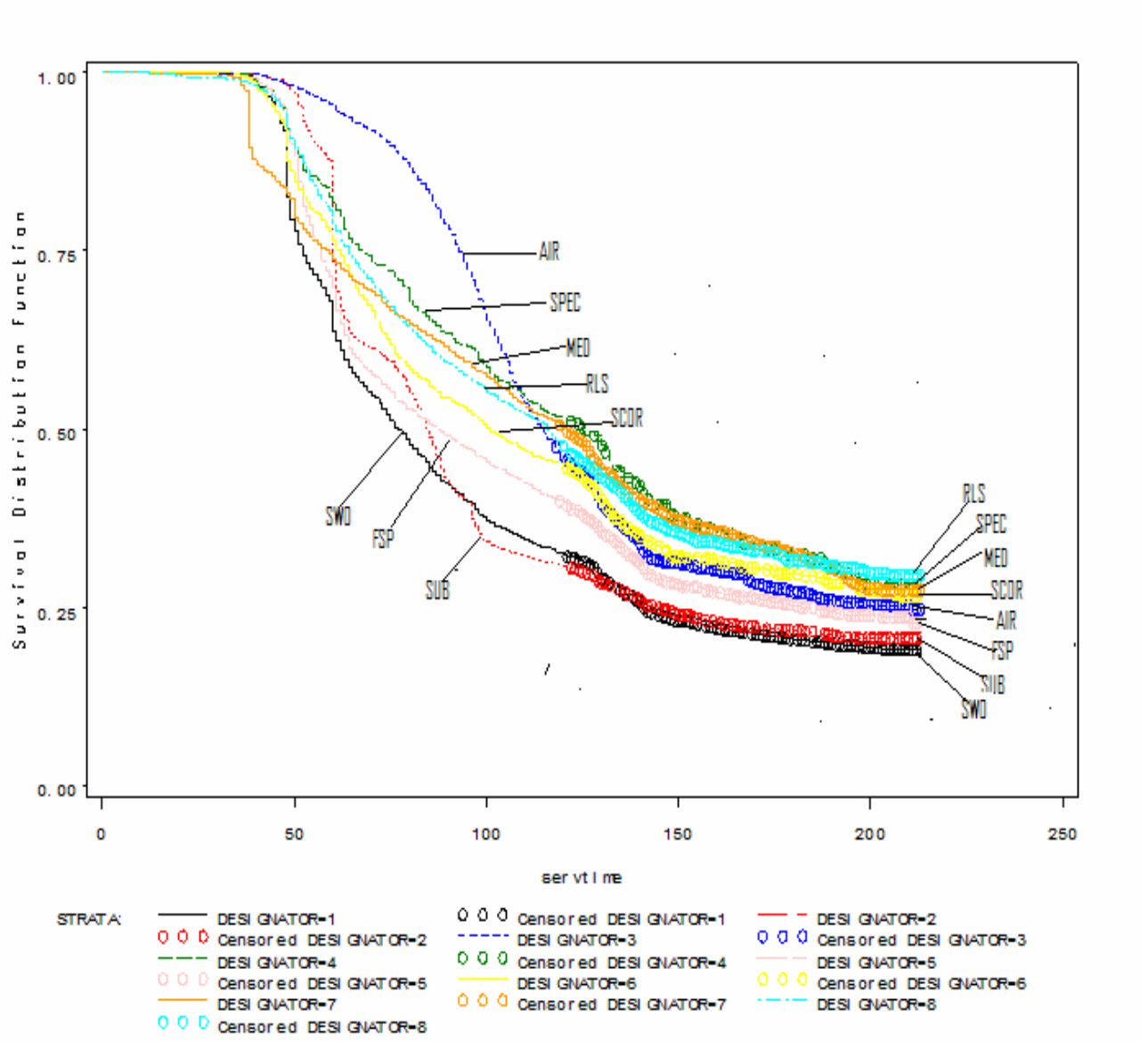

Figure 16. Plot of the Survival Function of the Variable DESIGNATOR.

The Kaplan-Meier (K-M) method is not suitable for large data sets because it produces long tables that may be unwieldy for presentation and interpretation. The life-table method is advantageous for this type of data because event times can be grouped. Also, the life-table method can produce estimates and plots of the hazard function, which are not available for the K-M method. Table 24 shows the survival estimates of the life-table method for Naval officers. The life-table method constructs an interval. For this data, nine intervals are defined. Each interval describes a two-year service time length. For each interval, 14 different statistics are reported. Most of them are self-explanatory.

The effective sample size for the first four intervals, without censored observations, is just the number of the officers who have not left the service at the start of the interval. For the censored intervals, the life-table method treats any cases censored within an interval as if they were censored at the midpoint of the interval. Since censored cases are only at risk for half of the interval, they only count for half in figuring the effective sample size. The conditional probability of failure is an estimate of the probability that an officer will leave the service in the interval, given that he/she made it to the start of the interval. An estimate of its standard error is given in the next panel. The survival column is the life-table estimate of the survival function, that is, the probability that the event occurs at a time greater than or equal to the start time of each interval. Failure is simply 1 minus survival. The median residual lifetime column is, in principle, an estimate of the remaining time until an event for an individual who survived to the start of the interval. The PDF column is an estimate of the probability density function at the midpoint of the interval. The hazard column, which is important, gives estimates of the hazard function at the midpoint of each interval.[136]

Table 24. Life-Table Survival Estimates.

INTERVALS		NUM, FAILED	NUM. CENS.	EFF. SAMPLE SIZE	COND. PROB. OF FAILURE	COND. PROB. STD. ERR.	SURV.	FAIL.
LOWER	UPPER							
0	24	22	0	34960	0.000629	0.000134	1	0
24	48	1867	0	34938.0	0.0534	0.00120	0.9994	0.000629
48	72	8353	0	33071.0	0.2526	0.00239	0.9460	0.0540
72	96	5517	0	24718.0	0.2232	0.00265	0.7070	0.2930
96	120	4746	3	19199.5	0.2472	0.00311	0.5492	0.4508
120	144	3437	2814	13045.0	0.2635	0.00386	0.4135	0.5865
144	168	691	2329	7036.5	0.0982	0.00355	0.3045	0.6955
168	192	383	2598	3882.0	0.0987	0.00479	0.2746	0.7254
192	216	65	2135	1132.5	0.0574	0.00691	0.00691	0.2475

[136] Paul D. Allison, *Survival Analysis Using SAS* (SAS Publishing, North Carolina, 2003), 46.

INTERVALS		SURV. STD. ERR.	MED. RES. LIFETIME	MED. STD. ERR.	PDF	PDF STD. ERR.	HAZARD	HAZARD STD. ERR.
LOWER	UPPER							
0	24	0	104.7	0.4727	0.000026	5.58E-6	0.000026	5.592E-6
24	48	0.000134	80.7578	0.4726	0.00223	0.000050	0.002288	0.000053
48	72	0.00121	61.4781	0.4598	0.00996	0.000095	0.012045	0.00013
72	96	0.00243	61.2064	0.4954	0.00658	0.000081	0.010468	0.00014
96	120	0.00266	72.0063	1.7555	0.00566	0.000076	0.011752	0.000169
120	144	0.00263	.	.	0.00454	0.000072	0.012644	0.000213
144	168	0.00251	.	.	0.00125	0.000046	0.004303	0.000163
168	192	0.00251	.	.	0.00113	0.000056	0.004324	0.000221
192	216	0.00262	.	.	0.000592	0.000072	0.002462	0.000305

Figure 17 shows the survival function of the Naval officers and Figure 18 shows the hazard estimates for the Naval officers for two year intervals. As shown in Figure 5, the hazard ratio of Naval officers increases to the highest point after completing the initial obligated service time. It then slightly decreases up to the O-4 promotion point. At the O-4 promotion point, it increases again to the same level where it was at the point of completing obligated time. After the O-4 promotion point of about 10 years or 120 months, the hazard ratio decreases greatly.

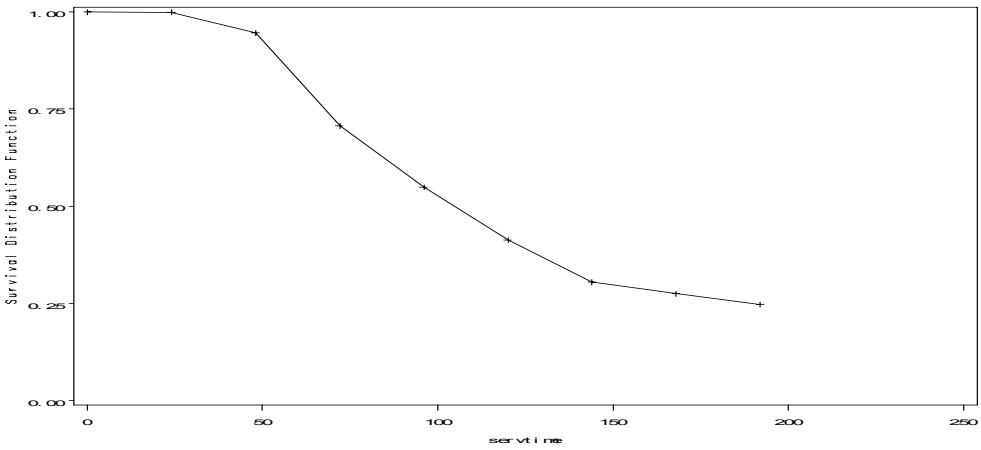

Figure 17. Life-Table Survival Estimates.

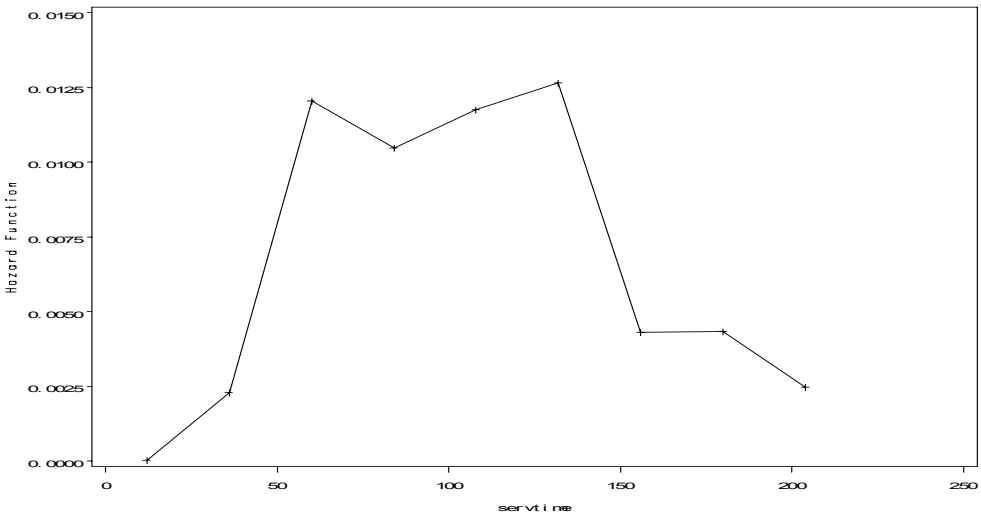

Figure 18. Life-Table Hazard Estimates for 2 Years Intervals.

Figure 19 shows the hazard estimates function for six months intervals. This graph is more detailed than the two year-interval graph. Here, the hazard increases can be seen around 48 months for ROTCSK, RPTCC and OCS and around 60 months for USNA graduates. The increases around 120, 140, 170 and 180 months are mostly hazard increases after promotion points for the officers who did not receive a promotion.

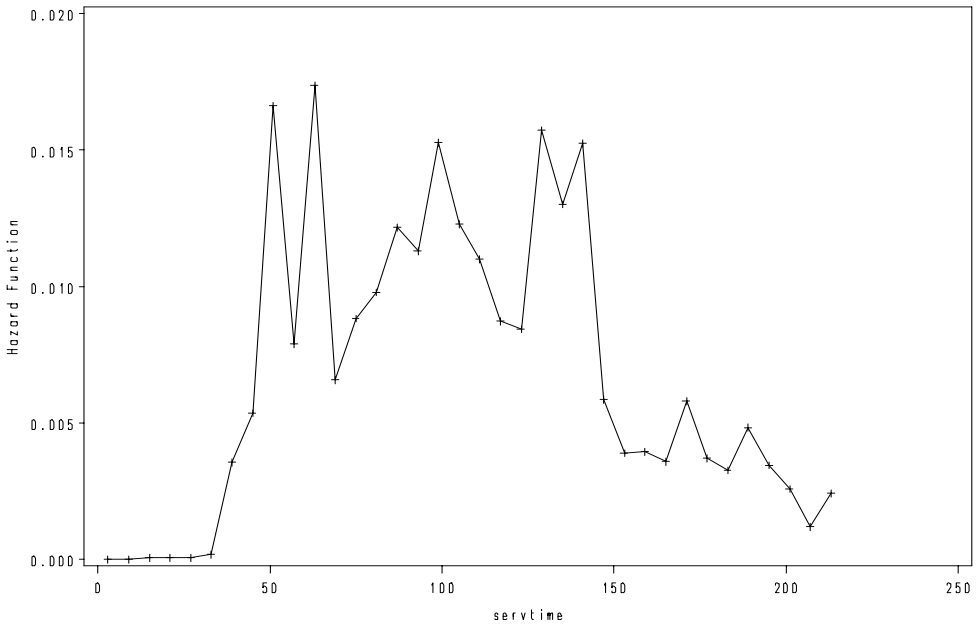

Figure 19. Life-Table Hazard Estimates for 6 Months Intervals.

"PROC LIFETEST is a useful procedure for preliminary analysis of survival data and for testing simple hypotheses about differences in survival across groups."[137] However, the procedure is not useful for examining the effects of variables controlling for other covariates. Also, it is not useful for two-way interactions. Therefore, in most situations, PROC LIFEREG or PROC PHREG procedures will be necessary to estimate regression models.[138]

C. ESTIMATING PARAMETRIC REGRESSION MODELS WITH PROC LIFEREG

The LIFEREG procedure uses the method of maximum likelihood to produce estimates of regression models. Chapter IV discusses the differences between PROC LIFEREG and PROC PHREG . As mentioned, the weakest feature of the PROC LIFEREG is that it does not allow for the use of time-dependent covariates, while PROC PHREG does.

The class of regression models estimated by PROC LIFEREG is known as the accelerated failure time (AFT) model. The AFT model describes a relationship between

[137] Paul D. Allison, *Survival Analysis Using SAS* (SAS Publishing, North Carolina, 2003), 59.

[138] Ibid.

the survival functions of any two individuals. Since the mathematical theory in the background of PROC LIFEREG is complicated, it is not explained here (see Allison, 2003). The main difference between AFT models and usual linear regression models is censored observations. Censored observations are difficult to handle with OLS. AFT models use maximum likelihood estimation to deal with censored observations. PROC LIFEREG allows the use of Weibull, exponential, gamma, log-logistic, and log-normal distributions in the survival analysis. It is possible to use a set of alternative distributions for modeling the distribution of T and that of ε, as shown below:

Distribution of ε	**Distribution of T**
Extreme value (2 parms)	Weibull
Extreme value(1 parm)	Exponential
Log-gamma	Gamma
Logistic	Log-logistic
Normal	Log-normal

Table 25 shows the results of the PROC LIFEREG procedure assuming Log-normal, exponential, Weibull and Gamma distributions. In the model with the log-normal distribution, the variables AGECOMM, FEMALE, MWC, ROTCSK, OCS, SOMEPRIOR, SELCOLL, SWO, SUB, AIR, FSP, SCOR, YRG83, YRG84, YRG85, YRG86, YRG87 and BLACK (0.0002) are significant at the 0.01 significance level. MED (0.0241) is significant at the 0.05 level, and YRG88 (0.0545) and YRG89 (0.0565) are significant at the 0.1 significance level.

The signs of the coefficients shows the direction of the relationship. The numerical magnitudes of the coefficients are not very informative in the reported metrics and must be transformed. By taking e^{β}, it is possible to obtain the estimated ratio of the expected (mean) survival times for the two groups. For example, for female officers $e^{0.08004}$=1.0833. Therefore, controlling for the other covariates, the expected service time for a female officer is 8.33 % longer than a male officer. For a quantitative variable like AGECOMM, the formulae is $100\times(e^{\beta}-1)$, which gives the % increase in the expected survival time for each one year increase in the age of officers. Thus, $100\times(e^{0.02187}-1)$=2.211. Then, the model shows that each year increase in the commissioning age of an officer results is a 2.211% increase in the officers' expected service time. By using the

same formulae, African American officers' expected service time is 7.19% longer than white officers' expected service time. Married with no children officers' expected service time is 4.35% longer and, married and with children officers' expected service time is 9.52% longer than single with no children officers' expected service time. Similarly, NROTC Scholarship graduates' expected service time is 8.32% longer, NROTC Contract graduates' expected service time is 7.39% shorter and OCS graduates' expected service time is 14.66% shorter than USNA graduate officers' expected service time. Officers with prior service have 11.60% longer expected service time in the Navy than officers with no prior service. Officers who graduated from selective colleges have an 8.05% shorter expected service time than other officers. SWOs have a 24.92% shorter, Submarine Officers have a 19.64% shorter, AIR Community Officers have 8.9% longer, Fleet Support Officers a 17.02% shorter, Supply Corps Officers has 11.82% shorter, and Medical officers have 16.43% longer expected service time than Restricted Line and Staff officers.

Officers commissioned at year 1983 have 21.75% longer, officers commissioned at year 1984 have 15.73% longer, officers commissioned at year 1985 have 14.48% longer, officers commissioned at year 1986 have 8.6% longer, officers commissioned at year 1987 have 5.3% longer, officers commissioned at year 1988 have 3.16% longer, and officers commissioned at year 1989 have 3.15% longer expected service time than officers commissioned at year 1990.

The output line labeled SCALE is an estimate of the σ parameter. For some distributions, a change in the value of this parameter can produce qualitative differences in the shape of the hazard function. However, for the log-normal model, changes in this parameter only compress or stretch the hazard function.[139]

Table 25 also shows that the choice of model can make a substantive difference. The results of the LNORMAL and WEIBULL models are closer to each other than the EXPONENTIAL model. Same variable are significant in all three models, but the significance level is different for some variables such as FEMALE, ROTCSK,

[139] Paul D. Allison, *Survival Analysis Using SAS* (SAS Publishing, North Carolina, 2003), 66.

OTHERSOURCE and YRG85. There is large difference in the significance level of the variables YRG87, YRG88 and YRG89 between the LNORMAL and the EXPONENTIAL models.

Table 25. Results of PROC LIFEREG Procedure by Log-Normal, Exponential and Weibull Distributions.

DIST	**LNORMAL**		**EXPONENTIAL**		**WEIBULL**		**GAMMA**	
LOG LIKELIHOOD	**-22816.535**		**-29935.554**		**-25298.61**		**-20514.02**	
VARIABLE	**ESTIMATE**	**PR> CHISQ**	**EST.**	**PR> CHISQ**	**ESTIMATE**	**PR> CHISQ**	**EST.**	**PR> CHISQ**
INTERCPT.	4.25072	<.0001	4.66361	<.0001	4.56014	<.0001	4.05263	<.0001
AGECOMM	0.02187	<.0001	0.0235	<.0001	0.017	<.0001	0.0094	<.0001
BLACK	0.06947	0.0002	0.11812	0.002	0.07928	<.0001	0.00875	0.5266
HISP	-0.00480	0.8545	0.01256	0.8141	0.00369	0.8906	-0.0171	0.3843
OTHER	-0.02202	0.4082	-0.0488	0.3552	-0.0322	0.2261	-0.0347	0.0852
FEMALE	0.08004	<.0001	0.08279	0.0389	0.06819	0.0012	0.0225	0.0707
SWC	0.0637	0.1941	0.02414	0.8061	0.0304	0.539	0.09384	0.0111
MNC	0.04256	0.0654	0.09319	0.0485	0.06578	0.0055	0.02893	0.0989
MWC	0.09099	<.0001	0.14864	<.0001	0.10034	<.0001	0.05144	<.0001
ROTCSK	-0.07674	<.0001	-0.0881	<.0001	-0.05814	<.0001	-0.0934	<.0001
ROTCC	-0.02213	0.3176	0.02137	0.6384	0.01759	0.4423	-0.1167	<.0001
OCS	-0.15852	<.0001	-0.1681	<.0001	-0.11521	<.0001	-0.1762	<.0001
OTHER	-0.02648	0.3369	-0.0134	0.817	-0.00923	0.751	-0.1324	<.0001
SOMEPRI	0.10982	<.0001	0.1316	0.0004	0.08537	<.0001	0.09873	<.0001
SELCOLL	-0.08399	<.0001	-0.1318	<.0001	-0.0938	<.0001	-0.0223	0.0083
NAPC	0.00282	0.4929	0.00204	0.8072	0.0033	0.4321	-0.0020	0.5192
TECHMAJ	0.00778	0.3378	0.01952	0.2354	0.0127	0.1262	0.01209	0.0458
GRADEDU	0.02587	0.3611	0.05216	0.3757	0.02906	0.3272	0.01559	0.4584
SWO	-0.28674	<.0001	-0.4151	<.0001	-0.2767	<.0001	-0.1431	<.0001
SUB	-0.21866	<.0001	-0.3820	<.0001	-0.2618	<.0001	-0.0294	0.0216
AIR	0.08531	<.0001	-0.0437	0.1822	-0.0261	0.1131	0.24628	<.0001
SPEC	-0.03819	0.2101	-0.0618	0.3371	-0.03518	0.2778	0.02149	0.3145
FSP	-0.1866	<.0001	-0.2574	<.0001	-0.17989	<.0001	-0.0762	<.0001
SCOR	-0.12585	<.0001	-0.1793	<.0001	-0.11551	<.0001	-0.0719	<.0001
MED	0.15217	0.0241	0.38352	0.0191	0.20004	0.0151	0.06683	0.1393
YRG83	0.19681	<.0001	0.22408	<.0001	0.32544	<.0001	0.11474	<.0001

DIST	LNORMAL		EXPONENTIAL		WEIBULL		GAMMA	
LOG LIKELI HOOD	-22816.535		-29935.554		-25298.61		-20514.02	
VARIABLE	ESTIMATE	PR> CHISQ	EST.	PR> CHISQ	ESTIMATE	PR> CHISQ	EST.	PR> CHISQ
YRG84	0.14613	<.0001	0.13374	<.0001	0.24183	<.0001	0.10582	<.0001
YRG85	0.1352	<.0001	0.11918	0.0003	0.2088	<.0001	0.11398	<.0001
YRG86	0.08249	<.0001	0.03119	0.3382	0.12875	<.0001	0.09434	<.0001
YRG87	0.0517	0.0015	-0.0092	0.7797	0.07666	<.0001	0.05937	<.0001
YRG88	0.03113	0.0545	-0.0280	0.3966	0.04064	0.0148	0.05617	<.0001
YRG89	0.031	0.0565	0.01005	0.7647	0.03452	0.0412	0.03968	0.001
SCALE	0.56642		1		0.50341		0.443	
SHAPE							-1.7556	

These models with different distributions generally produce similar coefficient estimates and p-values as in Table 25. To decide among these models, several methods are available. One method is using log-likelihoods. If one model is nested within another model, to evaluate the fit of the first model twice, the positive difference in the log-likelihoods of the two models is used. Usually, the Weibull and log-normal models are all nested within the generalized gamma model, making it a simple matter to evaluate them with the likelihood ratio test.[140]

The log-likelihoods for the models are:

-29941.13138 Exponential
-22816.53556 Lnormal
-25298.61136 Weibull
-23188.62931 Llogistic
-20514.02116 Gamma

[140] Paul D. Allison, *Survival Analysis Using SAS* (SAS Publishing, North Carolina, 2003), 89.

Since these log-likelihoods are all negative, lower magnitudes correspond to a better fit.[141] The Gamma model fits best considering only log-likelihoods. Likelihood ratio tests conducted by taking the differences between nested models and multiplying by 2 yields the following likelihood-ratio chi-square statistics:

-9285.04	Exponential vs., Weibull
-18854.2	Exponential vs. Gamma
-9569.18	Weibull vs. Gamma
-4605.03	Lnormal vs. Gamma
-5349.22	Llogistic vs. Gamma

The exponential model must be rejected. The Weibull and Logistic models are rejected as well. The best fitting models are the Lnormal and Gamma models, but the best choice is the Gamma model because of its low log-likelihood value.

Another way to decide which model fits best is to use graphical diagnostics. Specifically, if the distribution of event times fits the model, a plot of –logS(t) versus t should yield a straight line with an intercept at 0. The graphs for each model are shown in Figures 20 to 24. As Figure 11 shows, the Gamma distribution fits the model best.

[141] Ibid.

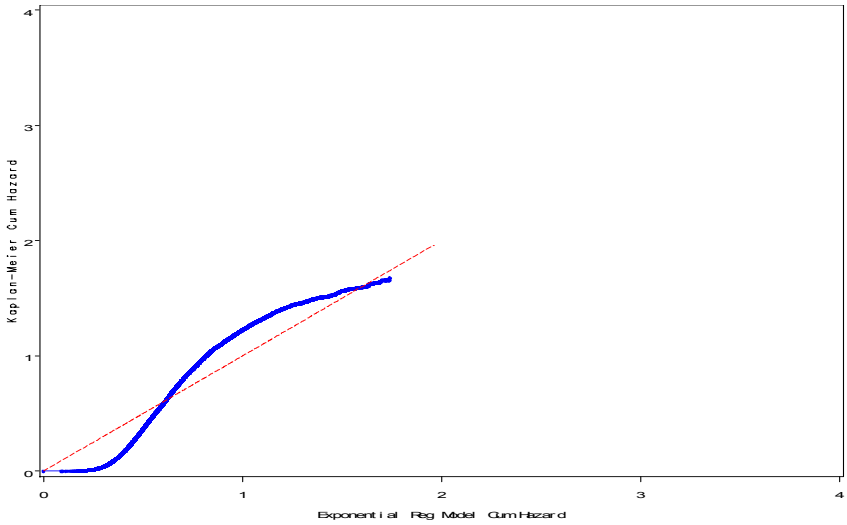

Figure 20. Residual Plot for Exponential.

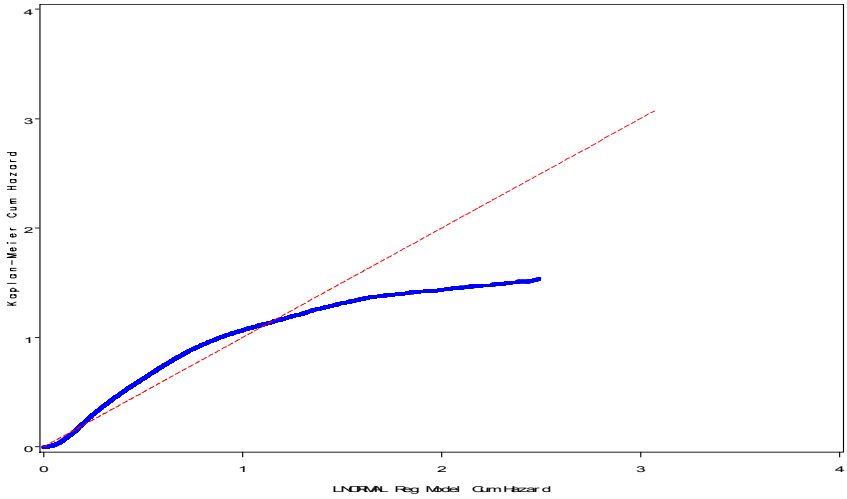

Figure 21. Residual Plot for Lnormal Model.

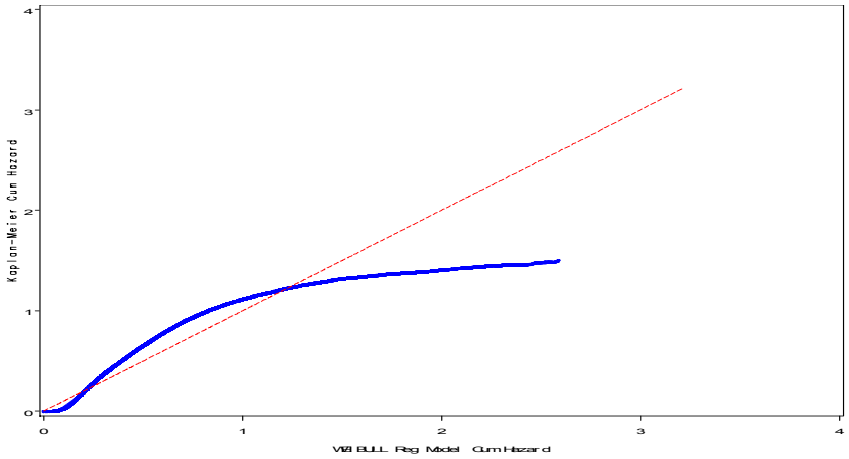

Figure 22. Residual Plot for Weibull Model.

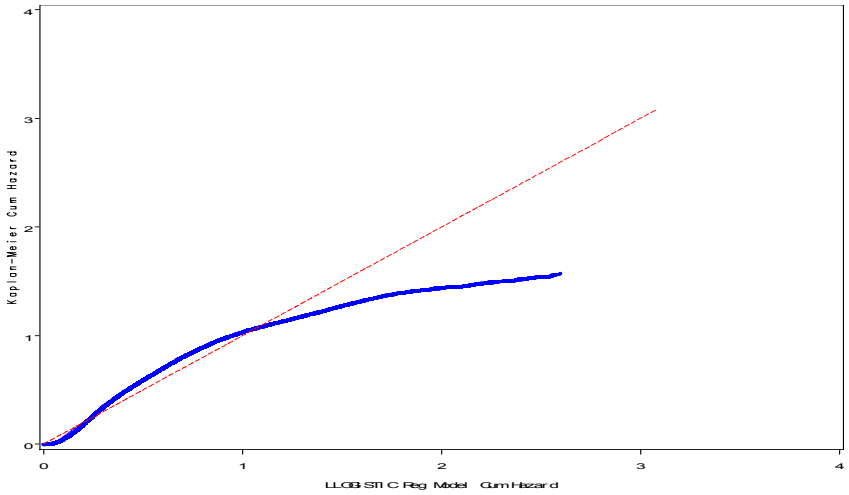

Figure 23. Residual Plot for Llogistic Model.

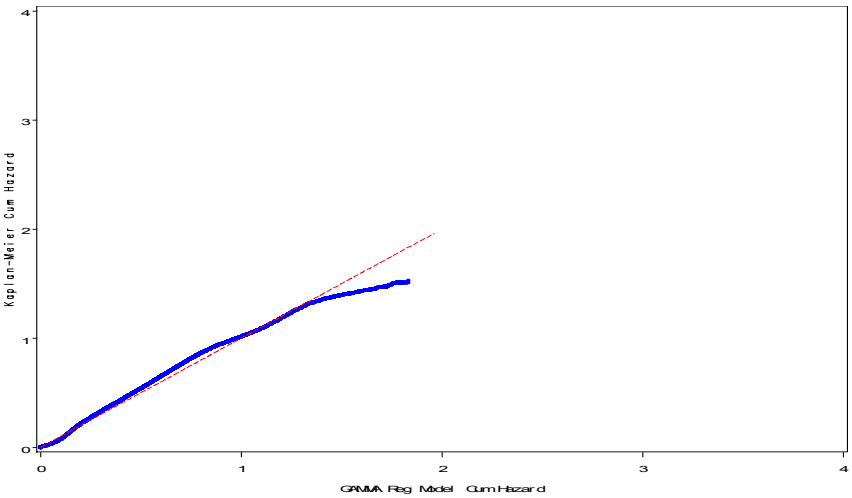

Figure 24. Residual Plot for Gamma Model.

PROC LIFEREG provides effective models for regression analysis of censored survival data. The results are less robust than the more widely used Cox regression analysis performed by PROC PHREG, but in most cases, the results are similar.

D. ESTIMATING COX REGRESSION MODELS WITH PROC PHREG

PHROC PHREG is the newest and most widely used SAS procedure for Cox regression analysis. The Cox regression model was proposed by David Cox in 1972 and then became very popular.[142] The PROC PHREG procedure combines the maximum partial likelihood method and the Proportional Hazards Model.

The Cox regression model is also called a semi-parametric model because, in order to represent survival times, it is not necessary to choose some particular probability distribution. The second biggest advantage of the method is that it allows the use of time-dependent covariates, which may change their values during the observation time. The main disadvantage of the Cox Regression is that it cannot test hypothesis about the shape of the hazard function as PROC LIFEREG does.[143]

The proportional hazards and maximum partial likelihood method is constructed on a basic model, which is:

$$h_i(t) = \lambda_0(t)\exp\{\beta_1 x_{1l} + \beta_k x_{ik}\}$$

where, $\lambda_0(t)$ is the baseline hazard function, which can be regarded as the hazard function for an individual whose covariates all have values of 0 and k is the number of fixed covariates.

By taking the logarithm of both sides, the model can be written as:

$$\text{Log}h_i(t) = \alpha(t) + \beta_1 x_{il} + ... + \beta_k x_{ik}$$

where $\alpha(t) = \log\lambda_0(t)$.

In the Cox regression, the function $\alpha(t)$ can take any form. The amazing point of partial likelihood is that the estimation of the β coefficients of the proportional model

[142] David Cox, *"Regression Models and Life Tables," Journal of the Royal Statistical Society,* Series B, (1973): 187-220.

[143] Paul D. Allison, *Survival Analysis Using SAS* (SAS Publishing, North Carolina, 2003), 29.

can be done without having to specify the baseline hazard function $\lambda_0(t)$. Due to that feature, Cox Regression does not need any distribution to estimate the covariates.[144]

As the result of Cox Regression, as a characteristic of partial likelihood estimation, there is no intercept estimate. The estimated coefficients are the logarithms of the hazard ratio attributed to the covariate, and the result of taking the exponential of the coefficient will be the hazard ratio. The hazard ratio gives the estimated % change in the hazard for one unit increase in the covariate. Any value less than one is a decrease, and more than one is an increase, in the hazard.

Dealing with ties is important in Cox Regression. A tie occurs when two or more events occur at the same time in a data. It is common for data to contain tied event times. To handle ties, PROC PHREG uses Breslow's approximation as the default method, which works well when ties are few. The other methods are Efron's method and two exact likelihood methods, which are named the exact and discrete methods. Exact methods are considered to be superior because they give the exact likelihoods where the Breslow and Efron methods give approximations.[145] Since the software is available, the exact method is used in dealing with ties in this thesis.

Table 26 shows the regression results using the PROC PHREG procedure. Three different models were estimated. The first model examines all officers in one category without differentiating by their designators. The second model separates officers into their designators, and the third model does not control for the commissioning year.

1. Model 1 Results

The first model indicates that, ceteris paribus, officers who were older at the time of commissioning have a smaller hazard ratio than officers with younger commissioning ages. The hazard ratio of 0.967 indicates that a one year increase in commissioning age decreases the hazard by 100 (1-0.967)%, or 3.3%, ceteris paribus. For example, if all the other factors were same, the difference in hazard between a 26 and a 24 year-old officer at commissioning would be a 6.6% decrease for the 26 year-old.

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[144] Ibid., 114.

[145] Paul D. Allison, *Survival Analysis Using SAS* (SAS Publishing, North Carolina, 2003), 128.

The variable OTHER, which indicates that an officer's ethnicity is other than white, black or Hispanic, was found to be significant at the 0.05 significance level, while the black and Hispanic variables were not significant. Officers with other ethnicity have a 12.7% higher hazard than white officers. This result is different from most of the literature, where minority groups generally have a tendency to stay longer than whites, but this result is the same as in Bernard and Mehay's retention results.[146]

The size of the hazard for a female officer is 86.5% of that for a male officer. This result is highly significant at the 0.01 level. Female officers are more likely to stay in the Navy than male officers. This result is also not parallel to the literature, where most studies have found that turnover is higher among females than males.

The MNC and MWC variables are found to be significant, with MNC significant at the 0.05 level and MWC highly significant at the 0.01 level. An officer who is married with no children has a hazard that is 90.2% of that of a SNC officer, while an MWC officer has a hazard that is 0.824 less than the hazard of a SNC officer, all else being equal. This effect implies that officers are much more likely to remain in the Navy when they are married. This result is parallel with the literature that consistently shows decreased turnover for married employees.

The variables ROTCSK and OCS are found to be highly significant, at the 0.01 levels, while the OTHERSOURCE variable is significant at the 0.05 level. The variable ROTCC is not significant. The OCS graduates exhibited 117.3% of the hazard of officers commissioned through USNA, while ROTCSK graduates exhibited 112.7%, and officers commissioned through other sources exhibited 88.6% of the hazard of USNA graduates.

The first model indicates that prior enlisted officers have a smaller hazard ratio, about 91%, than that of a non-prior enlisted officer. This result is highly significant at the 0.01 level. This is parallel to the findings of previous research. An officer who graduated from a highly selective college has 123.7% of the hazard of those who did not. This is highly significant (at the 0.01 significance level). This result corresponds with the discussion in the literature, because highly selective college graduates are more likely to

146 Joel P Bernard, and Stephen L. Mehay, *An Analysis of Alternate Accession Sources for Naval Officers*. (Monterey, California: Naval Postgraduate School, May 2003).

have a high probability of finding a job in the civilian labor market. An officer with a high undergraduate GPA has a hazard that is 96.2% of that of other officers. This is highly significant at the 0.01 level. This result also corresponds to the literature.

The results for variables TECHMAJ, GRADEDU, YRG87, YRG88, and YRG89 are not significant. The control variables YRG83, YRG84 and YRG85 are highly significant (at the 0.01 level). The base year was 1990. An officer commissioned at 1983 has 80.6%, 1984 commissioner has 86.7%, 1985 commissioner has 88.3% of the hazard of an officer commissioned at the year 1990. The variable YRG86 is significant at the 0.1 level. The hazard of an officer commissioned in the year 1986 is 96.4% of that of an officer commissioned in the year 1990.

2. Model 2 Results

The designator variables are added to estimate Model 2. The base case for the designators is RLS. SWO, SUB, FSP, SCOR designators are found to be highly significant (at the 0.01 level), and MED is found significant at the 0.05 level. An officer from the Surface Warfare Community has 173.5% of the hazard of an officer from the RLS Community, while a Submarine officer has 160.9%, a Fleet Support officer has 141.3%, a Supply Corps officer has 125.4% and a Medical officer has 68%. The results for AIR and SPEC were not significant.

Adding designators into the model changed the regression results for some variables. The significance and hazard ratios of the variables AGECOMM, FEMALE, MWC and TOPCOLL did not change considerably. The variable BLACK was not significant in the first model but in the second model it became highly significant at the 0.01 significance level. The hazard of a black officer is 85.3% of a white officer. This result is parallel to the literature. Also, the variable OTHER became insignificant in Model 2. The significance of the variable MNC is increased and the hazard ratio decreased. The hazard ratio of ROTCSK increased by 4%, and the hazard ratio of OCS increased by 10%. The variable OTHERSOURCE became insignificant.

The significance of the variable SOMEPRIOR increased, while its hazard ratio decreased by 7%. The variable NAPC became insignificant.

The significance level of the control year variables increased, and the variable YRG86 became highly significant, at the 0.01 level. The variables YRG87 and YRG89 became significant at the 0.05 level and the variable YRG88 became significant at the 0.1 level.

3. Model 3 Results

The third model was a reduced form of Model 1, which removed the fixed effect variables for the commissioning year. The significance levels and hazard ratios of the variables did not change significantly, except that the significance level of the variable SOMEPRIOR decreased from the 0.05 level to the 0.1 level. The hazard ratios increased about 2%.

Table 26. The PHROC PHREG Regression Results.

	MODEL1			MODEL2			MODEL3		
	PARAM. EST.	PR > CHISQ	HAZ. RATIO	PARAM. EST.	PR > CHISQ	HAZ. RATIO	PARAM. EST.	PR > CHISQ	HAZ. RATIO
AGECOMM	-0.03404	<.0001	0.967	-0.03586	<.0001	0.965	-0.03454	<.0001	0.966
BLACK	-0.04116	0.2788	0.960	-0.15857	<.0001	0.853	-0.03606	0.3422	0.965
HISP	0.07522	0.1585	1.078	-0.00111	0.9834	0.999	0.07593	0.1540	1.079
OTHER	0.12836	0.0150	1.127	0.05793	0.2729	1.137	0.15187	0.0040	1.164
FEMALE	-0.14547	<.0001	0.865	-0.14026	0.0008	0.853	-0.14861	<.0001	0.862
SWC	-0.05391	0.5833	0.948	-0.07830	0.4258	0.999	-0.06706	0.4950	0.935
MNC	-0.10331	0.0281	0.902	-0.11594	0.0138	1.137	-0.10978	0.0196	0.896
MWC	-0.19347	<.0001	0.824	-0.18997	<.0001	0.853	-0.19484	<.0001	0.823
ROTCSK	0.1196	<.0001	1.127	0.12299	<.0001	1.131	0.13476	<.0001	1.144
ROTCC	-0.0057	0.8997	0.994	-0.0239	0.5991	0.976	-0.00092	0.9838	0.999
OCS	0.15994	<.0001	1.173	0.24516	<.0001	1.278	0.14592	<.0001	1.157
OTHER SOURCE	-0.12054	0.0287	0.886	0.02236	0.7013	1.023	-0.13437	0.0143	0.874
SOMEPRIOR	-0.09467	0.0096	0.910	-0.17914	<.0001	0.836	-0.08209	0.0237	0.921
SELCOLL	0.21229	<.0001	1.237	0.18557	<.0001	1.204	0.21145	<.0001	1.235

	MODEL1			MODEL2			MODEL3		
	PARAM. EST.	**PR > CHISQ**	**HAZ. RATIO**	**PARAM. EST.**	**PR > CHISQ**	**HAZ. RATIO**	**PARAM. EST.**	**PR > CHISQ**	**HAZ. RATIO**
NAPC	-0.03829	<.0001	0.962	-0.01050	0.2081	0.990	-0.03812	<.0001	0.963
TECHMAJ	0.00337	0.8300	1.003	-0.02468	0.1344	0.976	0.00686	0.6614	1.007
GRADEDU	-0.07334	0.2119	0.929	-0.05810	0.3237	0.944	-0.07282	0.2152	0.930
SWO				0.55091	<.0001	1.735			
SUB				0.47591	<.0001	1.609			
AIR				-0.00483	0.8828	0.995			
SPEC				0.07466	0.2462	1.078			
FSP				0.34541	<.0001	1.413			
SCOR				0.22669	<.0001	1.254			
MED				0.38505	0.0186	0.680			
YRG83	-0.21263	<.0001	0.808	-0.28887	<.0001	0.749			
YRG84	-0.14290	<.0001	0.867	-0.21001	<.0001	0.811			
YRG85	-0.12421	0.0002	0.883	-0.19998	<.0001	0.819			
YRG86	-0.05448	0.0959	0.947	-0.11341	0.0005	0.893			
YRG87	-0.01362	0.6820	0.986	-0.06804	0.0409	0.934			
YRG88	-0.01106	0.7392	0.989	-0.05859	0.0780	0.943			
YRG89	-0.02891	0.3901	0.972	-0.07081	0.0354	0.932			

E. DIFFERENTIATING VOLUNTARY AND INVOLUNTARY SEPARATIONS

In the previous sections, all the events in each analysis were treated as though they were identical, as if all separations were of the same type. However, in the data, separations are classified as voluntary and involuntary. In this part of the chapter, these different types of separations are examined to learn whether there are differences between these two groups of officers. For each type of separation, a separate hazard function is defined.

To examine voluntary and involuntary separations, PROC LIFETEST and PROC PHREG procedures are used. Figure 25 shows the log-log survival curves for voluntary and involuntary separations of officers. Not surprisingly, the curve for involuntary separations is much lower than for voluntary separations. After 120 months, the involuntary separations curve moves closer to the voluntary separations curve because of the up-or-out system in the Navy.

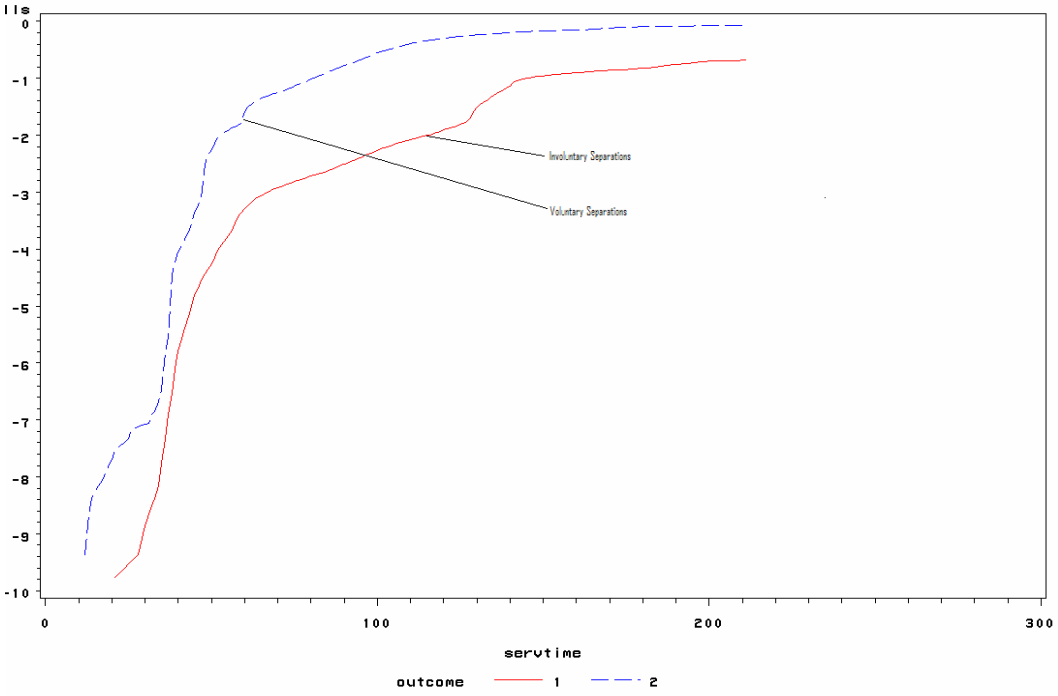

Figure 25. Log-Log Survival Plot for Voluntary and Involuntary Separations.

It is also possible to determine whether the effects of covariates are the same or different across these two event types by fitting a Cox model to each type. To accomplish this, three models were constructed. The first model treats all event types the same. This model is the same model as the second model in part three of this chapter. The second model in this part focuses on involuntary separations, by treating officers who have not separated and voluntarily separated officers as censored. The third model treats officers who have not separated and involuntarily separated officers as censored. Table 27 shows the results of the three models.

In all three models, commissioning age is highly significant at the 0.001 significance level. For involuntary separations, commissioning at older ages is a disadvantage, while for voluntary separations, it is an advantage, parallel to the results for the all separations model. For involuntary separations, the hazard ratio of 1.109 indicates that a one year increase in commissioning age increases the hazard by 100×(1-1.109) or 10.9%, where for voluntary separations, a one year increase in commissioning age decreases the hazard ratio 10.5%. The results of Cox Regression indicates that the magnitude of the effect of commissioning age on the length of service time is almost the same for voluntary and involuntary separations, but in different directions. These results are interesting, because they reflect different trends in involuntary and voluntary separations. An investigation of these very different effects should be the subject of another study.

Being African-American has a significant effect on the length of service time for voluntary and involuntary separations, but in different directions. For involuntary separations, being African-American increases the hazard ratio about 32%, while for voluntary separations, being African- American decreases the hazard ratio by 30%. The effect for the all separations model is a 14.7% decrease in the hazard compared to white officers. For all three models, the results are highly significant, at the 0.0011 significance level. These results also indicate a different pattern in voluntary and involuntary separations for African Americans. Another study must be done to explain these differences.

The size of the hazard of involuntary separations for female officers is 50.2% less than that for male officers. This result is highly significant at the 0.01 level. Female officers are less likely to be involuntarily separated from the Navy than male officers. For the voluntary separations model, the result for female officers is not significant. For the all separations model, female is highly significant and the hazard of a female officer is 86.9% of that of a male officer.

The variable SWC, indicating a single officer with children, was found to be significant for both the involuntary and voluntary separation models. The hazard ratio of

a SWC officer for involuntary separations compared to single officers with no children (SNC) is 35.1% higher and significant at the 0.05 significance level, while the hazard ratio for voluntary separation is 60% and significant at 0.01 significance level.

The variable MNC is significant in the all separations model (<0.05) and the involuntary separations (<0.01) model. Married without children (MNC) officers have 89.1% of the hazard of SNC officers in the all separations model and 65.1% in the involuntary separations model. The variable MWC is found highly significant (<0.001) in all three models. Married officers with children have a hazard that is 0.827% of that of a SNC officer in the all separations model, 81.4% in the involuntary separations model and 86% in the voluntary separations model, all else being equal.

The variables ROTCSK and OCS are found to be highly significant in all three models. The variable ROTCC is significant only in the voluntary separations model. The OTHERSOURCE variable is highly significant in both the involuntary and voluntary separations models at the 0.01 level. The OCS graduates exhibited a hazard of 127.8% of the hazard of the officers commissioned through USNA in the all separations model, 138.4% in the involuntary separations model and 130.7% in the voluntary separations model, while NROTC Scholarship graduates exhibited 113.1%, 123.1% and 111.4%, respectively. The officers commissioned through OTHERSOURCE exhibited 157.4% in the involuntary separations model and 69.8% in the voluntary separations model, of the hazard of the USNA graduates.

For involuntary separations, prior enlisted officers have a larger hazard, about 112.9% of that of non-prior enlisted officers. This result is significant at the 0.05 level. In the voluntary separations and in the all separations models, prior enlisted officers have smaller hazards, 63% and 83.6% respectively, compared to the hazard of non-prior enlisted officers. These results are highly significant (<0.001).

Officers who graduated from highly selective colleges had a hazard of 120.4% in the all separations model, 88.7% in the involuntary separations model and 126.8% of the hazard of their counterparts from less selective colleges. This is highly significant (at the 0.01 significance level) in the all separations and voluntary separations models and significant (<0.05) in the involuntary separations model. An officer with a high

undergraduate GPA has 113.1% of the hazard of other officers in the involuntary separations model. The hazard ratio is 94.8% in the voluntary separations model. Both results are highly significant at the 0.01 level.

A SWO officer has 173.5% of the hazard of a RLS officer in the all separations model, 129.8% in the involuntary separations model and 187.6% in the voluntary separations model. The results are highly significant (<0.001). An AIR officer has 135.8% of the hazard of RLS officer in the involuntary separations model and 89.9% in the voluntary separations model. These results are highly significant (<0.01).The results in model one and in model three are highly significant for submarine officers. In the all separations model, a submarine officer has 160.9% of the hazard of the base variable Other Restricted Line and Staff (RLS) officer. In the case of the involuntary separations, a submarine officer has 91.4% of the hazard of the RLS officer. The results of the Cox Regression for Fleet Support Officers are highly significant in all three models (<0.001). The hazard of Fleet Officer is 141.3% of the hazard of the RLS officer in the all separations model, 231.5% in the involuntary separations model and 122.7% in the voluntary separations model. The hazard of a Supply Corps officer is 125.4%, 123%, and 128% of the hazard of the Other Restricted Line and Staff officers, in the first, second and third models. The results are highly significant in all models (<0.001). The results for Medical officer is significant in the all separations model (<0.05) and in the voluntary separations model (<0.01).The hazard of a medical officer is 68 % of the hazard of RLS officer in the all separations model and 42.6 % of the hazard in the voluntary separations model. The effect of graduate education is significant only in the involuntary separations model (<0.01). The hazard of an officer with a graduate education is 62% of the hazard of officer without graduate education in the involuntary separations.

Table 27. PROC PHREG Analysis for Involuntary And Voluntary Separations.

	ALL SEPARATIONS			INVOLUNTARY SEPARATIONS			VOLUNTARY SEPARATIONS		
	TOT.	**EVENT**	**CENS.**	**TOTAL**	**EVENT**	**CENS.**	**TOTAL**	**EVENT**	**CENS.**
	26047	18450	7597	26047	4361	21686	26047	14089	11958
	PARAM. EST.	**PR > CHISQ**	**HAZ. RATIO**	**PARAM. EST.**	**PR > CHISQ**	**HAZ. RATIO**	**PARAM. EST.**	**PR > CHISQ**	**HAZ. RATIO**
AGECOMM	-0.03586	<.0001	0.965	0.10314	<.0001	1.109	-0.1114	<.0001	0.895
BLACK	-0.15857	<.0001	0.853	0.27787	<.0001	1.320	-0.3569	<.0001	0.700
HISP	-0.00111	0.9834	0.999	0.15473	0.1164	1.167	-0.0527	0.4072	0.949
OTHER	0.05793	0.2729	1.060	0.27526	0.0057	1.317	-0.03040	0.6261	0.970
FEMALE	-0.14026	0.0008	0.869	-0.68866	<.0001	0.502	0.00521	0.9096	1.005
SWC	-0.07830	0.4258	0.925	0.30079	0.0172	1.351	-0.51127	0.0015	0.600
MNC	-0.11594	0.0138	0.891	-0.42171	0.0002	0.656	-0.03499	0.5005	0.966
MWC	-0.18997	<.0001	0.827	-0.20547	<.0001	0.814	-0.18601	<.0001	0.830
ROTCSK	0.12299	<.0001	1.131	0.20754	<.0001	1.231	0.10792	<.0001	1.114
ROTCC	-0.02391	0.5991	0.976	0.49023	<.0001	1.633	-0.19050	0.0006	0.827
OCS	0.24516	<.0001	1.278	0.32495	<.0001	1.384	0.26748	<.0001	1.307
OTHER SOURCE	0.02236	0.7013	1.023	0.45335	<.0001	1.574	-0.35990	<.0001	0.698
SOMEPRIOR	-0.17914	<.0001	0.836	0.12158	0.0346	1.129	-0.46265	<.0001	0.630
SELCOLL	0.18557	<.0001	1.204	-0.12030	0.0211	0.887	0.23780	<.0001	1.268
NAPC	-0.01050	0.2119	0.990	0.12302	<.0001	1.131	-0.05342	<.0001	0.948
TECHMAJ	-0.02468	0.1344	0.976	-0.06911	0.0376	0.933	-0.00541	0.7760	0.995
GRADEDU	-0.05810	0.3237	0.944	-0.47861	0.0003	0.620	0.05668	0.3889	1.058
SWO	0.55091	<.0001	1.735	0.26065	<.0001	1.298	0.62913	<.0001	1.876
SUB	0.47591	<.0001	1.609	-0.08966	0.2871	0.914	0.54401	<.0001	1.723
AIR	-0.00486	0.8822	0.995	0.30636	<.0001	1.358	-0.10667	0.0062	0.899
SPEC	0.07466	0.2462	1.078	0.00477	0.9682	1.005	0.09353	0.2210	1.098
FSP	0.34541	<.0001	1.413	0.83944	<.0001	2.315	0.20474	0.0008	1.227

SCOR	0.22669	<.0001	1.254	0.20681	0.0059	1.230	0.24685	<.0001	1.280
MED	-0.38505	0.0186	0.680	-0.13318	0.5082	0.875	-0.85283	0.0040	0.426
YRG83	-0.28887	<.0001	0.749	-0.50032	<.0001	0.606	-0.20984	<.0001	0.811
YRG84	-0.21001	<.0001	0.811	-0.20124	0.0168	0.818	-0.20739	<.0001	0.813
YRG85	-0.19998	<.0001	0.819	-0.17840	0.0312	0.837	-0.19657	<.0001	0.822
YRG86	-0.11341	0.0005	0.893	0.10479	0.1930	1.110	-0.18554	<.0001	0.831
YRG87	-0.06804	0.0409	0.934	0.05842	0.4785	1.060	-0.10177	0.0056	0.903
YRG88	-0.05859	0.0780	0.943	0.05974	0.4700	1.062	-0.08950	0.0145	0.914
YRG89	-0.07081	0.0354	0.932	0.07006	0.4040	1.073	-0.10060	0.0065	0.904

VI. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

A. SUMMARY

In the beginning of Chapter V, PROC LIFETEST is used for preliminary analysis of survival data and for testing simple hypotheses about differences in survival across groups. The results of the PROC LIFETEST procedure gave information about the shape of the survival functions of Naval officers. The results of PROC LIFETEST showed that the survival functions of groups of Naval officers commissioned from different sources are not same. That is, officers from different commissioning sources follow different survival paths, especially after the end of obligated service time. It was found that, up to 80 months of service, USNA has the highest survival function for service time among commissioning sources, perhaps because of the longer initial obligated time. Between 80 and 120 months, NROTC Contract officers have the highest survival time. After 120 months, up to 170 months, OTHER commissioning source has the highest survival times and after 170 months OCS and NROTC Contract officers have the highest survival curve. For all of the times, NROTC Scholarship officers have the lowest survival function among commissioning sources.

Also, the differences between the survival functions of officers from different designators were examined. The Kaplan-Meier estimation method showed that the survival functions of officers from different designators were not the same. It was found that Aviators have the highest survival function for service time up to 100 months, most likely because of their longer initial obligation. After 100 months, the Special Warfare community had the highest survival function followed by Medical and other Restricted Line and Staff officers. Surface Warfare and Submarine officers showed the lowest survival function among the designators.

The life-table method was used to obtain estimates of the survival function and of the hazard function for Naval officers commissioned through years 1983-1990. Graphs were drawn to examine the hazard estimates at two-year intervals and six-month intervals

of service time. In particular, the six-month interval hazard estimates using the life-table method clearly showed the points at which the hazard increases or decreases during a Naval officers' career.

In the second part of Chapter V, the PROC LIFEREG procedure was used to estimate regression models for different distributions. Weibull, exponential, gamma, log-logistic and log-normal models were constructed. Both methods gave the same result that the gamma model fits the data best.

In the third part of Chapter V, the PROC PHREG procedure was used to construct Cox Regression models. Three models were estimated. The first model was constructed without differentiating by designator. The second model examined officers by their designator, and the variables show commissioning year was excluded from the third model.

At the last part of the chapter, the second model in part three is examined for voluntary and involuntary separations to learn whether there are differences between these two groups of officers. PROC LIFETEST procedure was used to show the log-log survival curves of groups of officers separated voluntarily and involuntarily. The graph showed that these two groups of officers have different survival functions. Also, the PROC PHREG procedure was used to construct two models: one for voluntarily separations and one for involuntarily separations. The results of these two models were compared with the results of the main model.

Table 28 summarizes the results found in Chapter V. PROC LIFETEST does not give coefficient estimates, so there is no way to quantify the effect of a covariate on survival time. In this thesis, PROC LIFETEST is used for preliminary analysis of survival data and to examine differences in survival across groups. The results of the PROC LIFEREG (Gamma model), the results of the PROC PHREG main model, and the models for voluntary and involuntary separations were compared. The estimates of coefficients of the PROC LIFEREG procedure were converted to the estimated ratio of the expected (mean) survival times by taking E^{β} of the estimates. Due to the different structure of the outputs, the significance level is used to compare PROC LIFEREG output with PROC PHREG output.

Table 28 shows that commissioning source was found to have a strong effect on survival rates with most commissioning sources exhibiting a negative effect on survival rates when compared with USNA graduates. In the PROC LIFEREG procedure, all of the commissioning sources were found highly significant, while in the PROC PHREG procedure, in the main model, NROTC Scholarship and OCS graduates are significant. In the Involuntary and Voluntary Separation models, officers commissioned through the NROTC Contract Program and OTHER SOURCE showed significant survival patterns in different directions, for involuntary separations model negative and for voluntary separations model positive effects.

Of the demographic variables, commissioning age was found to have a significant effect on the survival rates of officers. This effect was positive for total separations, but negative for involuntary separations. Being an African-American officer had a strong significant effect in Cox Regression models, and it was positive for all separations and negative for involuntary separations. The results of Cox Regression were significant for the variable FEMALE in all separations and involuntary separations models. Married officers with children also exhibited a strong and significant positive effect on the survival of officers.

The variables SOMEPRIOR and SELCOLL were significant in all models, while the involuntary separations model showed effects in different directions. SOMEPRIOR had a negative effect on involuntary separations and a positive effect on voluntary separations while SELCOLL had a positive effect on involuntary separations and negative effect on voluntary separations. The variable NAPC also, has exhibited significant effects on the survival of officers but in different directions, negative for involuntary separations and positive for voluntary separations. Among community designators, the Surface Warfare, Fleet Support and Supply Corps communities has significant and negative effects on the survival of officers compared to other designators. The Submarine community was significant in all models except the involuntary separations model, and the Air Community was significant in all models except the all separations model.

Table 28. Summary of the Results of Survival Model Estimates.

VARIABLE	LIFEREG GAMMA ESTIMATION (%)	PHREG ALL SEPARATIONS MODEL HAZARD RATIO	PHREG INVOLUNTARY SEPARATIONS MODEL HAZARD RATIO	PHREG VOLUNTARY SEPARATIONS MODEL HAZARD RATIO
		Demographics		
AGE_COMM	0.94***	0.965***	1.109***	0.895***
WHITE	Base	Base	Base	Base
BLACK	0.88	0.853 ***	1.320***	0.700***
HISP	-1.70	0.999	1.167	0.949
OTHER	-3.41*	1.137	1.317***	0.970
FEMALE	2.28*	0.853 ***	0.502***	1.005
MALE	Base	Base	Base	Base
SNC	Base	Base	Base	Base
SWC	9.84**	0.999	1.351**	0.600***
MNC	2.94*	1.137 **	0.656***	0.966
MWC	5.28***	0.853 ***	0.814***	0.830***
		Commissioning Sources		
USNA	Base	Base	Base	Base
ROTCSK	-8.92***	1.131***	1.231*	1.114
ROTCC	-11.01***	0.976	1.633***	0.827***
OCS	-16.15***	1.278***	1.384***	1.307***
OTHERSOURCE	-12.40***	1.023	1.574***	0.698***
		Career Characteristics		
SOMEPRIOR	10.38***	0.836 ***	1.129**	0.630***
		Human Capital Variables		
SELCOLL	-2.21***	1.204***	0.887**	1.268***
NONSELCOLL	Base	Base	Base	Base
NAPC	-0.20	0.990	1.131***	0.948***
TECHMAJ	1.22**	0.976	0.933**	0.995

GRADEDU	1.57	0.944	0.620***	1.058
		Community Designators		
SWO	-13.33***	1.735 ***	1.298***	1.876***
SUB	-2.90***	1.609 ***	0.914	1.723***
AIR	27.93***	0.995	1.358***	0.899***
SPEC	2.17	1.078	1.005	1.098
FSP	-7.34***	1.413 ***	2.315***	1.227***
SCOR	-6.94***	1.254 ***	1.230***	1.280***
MED	6.91	0.680 **	0.875	0.426***
RLS	Base	Base	Base	Base
		Control Variables		
YRG83	12.16***	0.749 ***	0.606***	0.811***
YRG84	11.16***	0.811 ***	0.818*	0.813***
YRG85	12.07***	0.819 ***	0.837*	0.822***
YRG86	9.89***	0.893 ***	1.110	0.831***
YRG87	6.12***	0.934 **	1.060	0.903***
YRG88	5.78***	0.943*	1.062	0.914*
YRG89	4.05***	0.932 **	1.073	0.904**
YRG90	Base	Base	Base	Base

* indicates significant at the 0.10 level, ** is significant at the 0.05 level and *** is significant at the 0.01 level

B. CONCLUSIONS

In this part, the findings of this thesis are compared to the findings of previous research. Since Bernard and Mehay used the same data and similar variables in their study, comparison of findings of these two studies would be helpful to understanding the factors that affect the survival of officers. Bernard and Mehay constructed multivariate logit models of retention and promotion to estimate the independent effect of accession source on URL and Restricted Line officer retention and promotion outcomes.[147] The findings in their retention models are compared to the survival results in this thesis.

[147] Joel P Bernard, and Stephen L. Mehay, *An Analysis of Alternate Accession Sources for Naval Officers*. (Monterey, California: Naval Postgraduate School, May 2003).

In the comparing these two studies, hazard ratios of less than one in the Cox model should generally have coefficients with a positive (+) sign in the logit model, and ratios greater than one should have coefficients with a negative (-) sign. Also, the significant variables in the logit model should be significant at the same significance level in the Cox Regression model or PROC LIFEREG model. The deviations between logit and Cox or PROC LIFEREG models could be explained by structural differences in the models. The logit retention model is only concerned with the group of officers in the 10-year retention decision phase. The logit model does not distinguish officers separated many years before or a short time before the retention decision (10-year) cut off point. As a result of that feature of the logit model, the results will differ from the Cox or LIFEREG models.[148]

Table 29 shows a summary of hypothesized and observed effects. In their study, Bernard and Mehay constructed separate retention models for URL officers and for RL officers. These models showed different results for some variables. Their URL model indicated that URL officers from ROTC-S and OCS are less likely to stay to the O-4 promotion board than USNA officers. Their RL model gave different results in that ROTC-C and OCS are more likely to stay than USNA. The results in the LIFEREG model and Cox model for commissioning sources were similar to the URL retention model. The OCS graduates exhibited 117.3% of the hazard of officers commissioned through the USNA, while ROTCSK graduates exhibited 112.7% of the hazard of the USNA graduates. Bernard and Mehay found that officers with technical degrees are 3.9% less likely to stay than officers who do not have technical degrees. Technical majors was significant in the LIFEREG model and in the involuntary separations model in this thesis. The LIFEREG model shows that officers with technical majors have 1.22% longer expected service time than their counterparts. This result is contrary to the findings of Bernard and Mehay.

Bernard and Mehay also found that officers with higher GPAs and officers with prior service are more likely to stay in the service, while female officers and officers from minority groups are less likely to stay in the service. In this thesis, the variable NAPC,

148 Phillip Hoglin, *Survival Analysis and Accession Optimization of Prior Enlisted United States Marine Corps Officers*, (Monterey, California: Naval Postgraduate School, March 2004), 45.

which indicates higher GPA, was found to be significant only in the involuntary and voluntary separations models. The involuntary separations model showed that officers with high GPAs have a higher hazard ratios than officers with low GPAs. In the voluntary separations model, the finding was the contrary. The voluntary separations model showed that officers with high GPAs have lower hazard ratios than officers with low GPAs. In almost all models, officers with prior enlisted service have smaller hazards (and longer expected service time) than officers with no prior service. An exception was the involuntary separations model. In the involuntary separations model, prior enlisted officers had a higher hazard ratio. Also, in most of the models, female officers had a lower hazard than male officers and African-American officers had a lower hazard than whites.

In their study, Bernard and Mehay showed results parallel to the literature about married officers being more likely to stay in the service. In this thesis, all the models also showed parallel results, with smaller hazards for married officers with children compared to single officers with no children.

Table 29. Summary of Hypothesized and Observed Effects.

VARIABLE	HYPOTHESIZED EFFECT	OBSERVED EFFECT LIFEREG	OBSERVED EFFECT PHREG	OBSERVED EFFECT INVOLUNTARY	OBSERVED EFFECT VOLUNTARY
Demographics					
AGE_COMM	+	+ ***	+ ***	- ***	+ ***
WHITE	Base	Base	Base	Base	Base
BLACK	+	+	+ ***	- ***	+ ***
HISP	+	-	+	-	+
OTHER	+	- *	-	- ***	+
FEMALE	-	+ *	+ ***	+ ***	-
MALE	Base	Base	Base	Base	Base
SNC	Base	Base	Base	Base	Base
SWC	+	+ **	+	- **	+ ***
MNC	+	+ *	+ **	+ ***	+
MWC	+	+ ***	+ ***	+ ***	+ ***
Commissioning Sources					
USNA	Base	Base	Base	Base	Base
ROTCSK	-	- ***	- ***	+ *	+
ROTCC	-	- ***	+	- ***	+ ***
OCS	-	- ***	- ***	- ***	- ***
OTHERSOURCE	-	- ***	-	- ***	+ ***
Career Characteristics					
SOMEPRIOR	+	+ ***	+ ***	- **	+ ***

Human Capital Variables					
SELCOLL	+	- ***	- ***	+ **	- ***
NONSELCOLL	Base	Base	Base	Base	Base
NAPC	+	-	+	- ***	+ ***
TECHMAJ	+	+ **	+	+ **	+
GRADEDU	+	+	+	+ ***	-
Community Designators					
SWO	-	- ***	- ***	- ***	- ***
SUB	-	- ***	- ***	+	- ***
AIR	+	+ ***	+	- ***	+ ***
SPEC	-	+	-	-	-
FSP	-	- ***	- ***	- ***	- ***
SCOR	-	- ***	- ***	- ***	- ***
MED	-	+	- **	+	+ ***
RLS	Base	Base	Base	Base	Base
Control Variables					
YRG83	?	+ ***	+ ***	+ ***	+ ***
YRG84	?	+ ***	+ ***	+ *	+ ***
YRG85	?	+ ***	+ ***	+ *	+ ***
YRG86	?	+ ***	+ ***	-	+ ***
YRG87	?	+ ***	+ **	-	+ ***
YRG88	?	+ ***	+ *	-	+ *
YRG89	?	+ ***	+ **	-	+ **
YRG90	Base	Base	Base	Base	Base

* indicates significant at the 0.10 level, ** is significant at the 0.05 level and *** is significant at the 0.01 level

C. RECOMMENDATIONS

There are many studies in the literature that have used logit and ordinary least squares methods for analysis of retention behavior of Naval officers. If censored data is used, survival analysis procedures are an alternative approach. This thesis is an aid to understanding the differences between survival methods and classic regression-type methods.

The findings in this thesis are also beneficial to an understanding of the survival patterns of officers. Due to the longer survival functions of USNA graduates, Navy decision makers might consider the USNA as the primary commissioning source to meet future demands. The importance of being married for career longevity was also highly significant in the results. The Navy may need to improve its policies toward married officers. The high turnover among Surface Warfare, Fleet Support and Supply Corps officers, as indicated in the results of the survival analysis, may lead to shortages in these communities. On the other hand, personnel to fill these shortages could be supplied by prior enlisted officers, who have low hazard ratios.

The results of the involuntary and voluntary separations models are intriguing and may bring new discussions to the literature. The different survival patterns among officers for Involuntary and Voluntary separations are a faithful subject for future research.

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