NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

UPDATING THE NAVY'S RECRUIT QUALITY MATRIX: AN ANALYSIS OF EDUCATIONAL CREDENTIALS AND THE SUCCESS OF FIRST-TERM SAILORS

by

Christopher D. Bownds

March 2004

Thesis Co-Advisor: Stephen L. Mehay
Thesis Co-Advisor: Mark J. Eitelberg

Approved for public release; distribution is unlimited.

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE March 2004	3. REPORT TYPE AND DATES COVERED Master's Thesis
4. TITLE AND SUBTITLE: UPDATING THE NAVY'S RECRUIT QUALITY MATRIX: AN ANALYSIS OF EDUCATIONAL CREDENTIALS AND THE SUCCESS OF FIRST-TERM SAILORS		5. FUNDING NUMBERS
6. AUTHOR(S) Christopher D. Bownds		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A		10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.	12b. DISTRIBUTION CODE

13. ABSTRACT (maximum 200 words)

This thesis analyzes the impact of different educational credentials on first-term attrition by enlisted sailors in the U.S. Navy. For enlistment screening, the Navy currently categorizes applicants in one of three tiers according to educational attainment. These tiers form the basis of the Recruit Quality Matrix, which employs Armed Forces Qualification Test scores and educational credentials to determine enlistment eligibility. The analysis draws primarily from two sources: a Defense Manpower Data Center file containing enlisted cohorts from fiscal years 1989 through 1997 (to assess first-term attrition), and a Commander, Navy Recruiting Command data base containing enlisted cohorts from fiscal years 1998 through 2003 (to examine bootcamp attrition). Logit regression models are constructed using these data to identify differences in attrition propensities within the general tiers. A refined matrix is designed and evaluated as a more accurate predictor of attrition. Further research is recommended to look at additional measures of success in service, such as performance, productivity, and promotion.

14. SUBJECT TERMS Navy, Attrition, Education, Credentials, Recruit, Matrix			15. NUMBER OF PAGES 97 16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited.

UPDATING THE NAVY'S RECRUIT QUALITY MATRIX: AN ANALYSIS OF EDUCATIONAL CREDENTIALS AND THE SUCCESS OF FIRST-TERM SAILORS

Christopher D. Bownds
Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1991

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

from the

NAVAL POSTGRADUATE SCHOOL
March 2004

Author: Christopher D. Bownds

Approved by: Stephen L. Mehay
Thesis Advisor

Mark J. Eitelberg
Co-Advisor

Douglas A. Brook
Dean, Graduate School of Business and
Public Policy

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

This thesis analyzes the impact of different educational credentials on first-term attrition by enlisted sailors in the U.S. Navy. For enlistment screening, the Navy currently categorizes applicants in one of three tiers according to educational attainment. These tiers form the basis of the Recruit Quality Matrix, which employs Armed Forces Qualification Test scores and educational credentials to determine enlistment eligibility. The analysis draws primarily from two sources: a Defense Manpower Data Center file containing enlisted cohorts from fiscal years 1989 through 1997 (to assess first-term attrition), and a Commander, Navy Recruiting Command data base containing enlisted cohorts from fiscal years 1998 through 2003 (to examine bootcamp attrition). Logit regression models are constructed using these data to identify differences in attrition propensities within the general tiers. A refined matrix is designed and evaluated as a more accurate predictor of attrition. Further research is recommended to look at additional measures of success in service, such as performance, productivity, and promotion.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

I. INTRODUCTION 1
- **A. BACKGROUND 1**
- **B. PURPOSE AND BENFITS OF THE STUDY 4**
- **C. ORGANIZATION OF THE THESIS 5**

II. LITERATURE REVIEW 7
- **A. HISTORICAL REVIEW OF ATTRITION RESEARCH BY APTITUDE AND EDUCATION LEVEL 7**
- **B. EDUCATION TRENDS 11**

III. ANALYSIS OF NAVY BOOTCAMP ATTRITION 15
- **A. DATA 15**
- **B. METHODOLOGY 16**
- **C. VARIABLES 16**
- **D. RESULTS 18**
  - 1. Bootcamp Attrition Trends 18
  - 2. Attrition by Educational Tier and Matrix Column 19
  - 3. Attrition by Educational Credential 26
  - 4. Summary of Results from CNRC Data Analysis ... 30

IV. ANALYSIS OF NAVY POST-BOOTCAMP ATTRITION 31
- **A. DATA 31**
- **B. METHODOLOGY 32**
- **C. VARIABLES 32**
  - 1. Educational Credential Variables 32
  - 2. Control Variables 33
- **D. RESULTS 36**
  - 1. First-Term Attrition Trends 36
  - 2. Attrition by Educational Tier and Matrix Column 36
  - 3. Attrition by Educational Credential 41
  - 4. Summary of Results from DMDC Data Analysis ... 44

V. RECRUIT QUALITY MATRIX VALIDATION 47

VI. POTENTIAL RECRUIT QUALITY MATRIX REFINEMENTS 55
- **A. MEDIUM-APTITUDE COLLEGE DEGREE-HOLDERS 55**
- **B. MEDIUM-APTITUDE TRADITIONAL HIGH SCHOOL GRADUATES . 56**
- **C. TIER I ALTERNATIVE CREDENTIAL-HOLDERS 58**
- **D. MEDIUM-APTITUDE B-CELL RECRUITS AND LOW-APTITUDE CU-CELL RECRUITS 59**
- **E. LOW-APTITUDE TRADITIONAL HIGH SCHOOL GRADUATES 60**

VII. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS 63
A. SUMMARY 63
B. CONCLUSIONS 64
C. FUTURE RESEARCH 65
1. Cost-Benefit Analysis 65
2. Alternative Measures of Military Success 65
3. First-Term Attrition Analysis of Home School Graduates 66

APPENDIX A. LOGIT REGRESSION RESULTS USING MATRIX COLUMNS AND EDUCATIONAL TIERS: 12- 24-, AND 36-MONTH ATTRITION .69

APPENDIX B. LOGIT REGRESSION RESULTS USING EDUCATIONAL VARIABLES: 12-, 24-, AND 36-MONTH ATTRITION 75

APPENDIX C. PREDICTED PROBABILITY OF 48-MONTH ATTRITION: DROPOUT3, GED2, CERT2, COLLSEM1, ADULT1, HSGRAD1, ASSOC1, AND BACH1 79

INITIAL DISTRIBUTION LIST 83

LIST OF FIGURES

Figure 1. Navy's Recruit Quality Matrix. 2
Figure 2. The Scarecrow Joins the Army. 12
Figure 3. GEDs Granted, 1971 through 2001. 13
Figure 4. Bootcamp Attrition Rates, Fiscal Years 1998 through 2003. 19
Figure 5. First-Term Attrition Rates by 12-Month Period, Fiscal Years 1989 through 1997. 36
Figure 6. Predicted Probability of First-Term Completion by AFQT Score and Educational Status. 53
Figure 7. Predicted Probability of First-Term Completion: Medium-Aptitude College Degree-Holders. 56
Figure 8. Predicted Probability of First-Term Completion: Medium-Aptitude Traditional High School Graduates. 57
Figure 9. Predicted Probability of First-Term Completion: Tier I Alternative Credential-Holders. 58
Figure 10 Predicted Probability of First-Term Completion: Medium-Aptitude B-Cell and Low-Aptitude Cu-Cell Recruits. 60
Figure 11 Predicted Probability of First-Term Completion: Low-Aptitude Traditional High School Graduates 61

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

Table 1. Navy Attrition Rates (Percent) Prior to Completion of the First Three Years of Active Duty, Fiscal Years 1973 through 1976 Non-Prior Service Male Accessions 10
Table 2. Educational Credentials. 17
Table 3. Bootcamp Attrition, Fiscal Years 1998 through 2003. 20
Table 4. Variable Descriptions and Descriptive Statistics. .21
Table 5. Logit Regression Results using Matrix Columns. 23
Table 6. Logit Regression Results using Educational Tiers. .24
Table 7. Partial Effects of AFQT and Educational Variables. 25
Table 8. Navy Bootcamp Attrition Rates by Educational Credential, Fiscal Years 1998 through 2003. 27
Table 9. Logit Regression Results for Educational Variables: Bootcamp Attrition. 29
Table 10. Partial Effects of Educational Credentials. 30
Table 11. Variable Descriptions and Descriptive Statistics. .35
Table 12. First-Term Attrition Rates (Percent), by 12-Month Periods, Fiscal Years 1989 through 1997. 37
Table 13. Logit Regression Results using Matrix Columns: 48-Month Attrition. 38
Table 14. Logit Regression Results using Educational Tiers: 48-Month Attrition. 39
Table 15. Partial Effects of AFQT and Educational Variables, by 12-Month Period. 40
Table 16. First-Term Attrition Rates (Percent), by 12-Month Period and Educational Credential. 41
Table 17. Logit Regression Results for Educational Variables: 48-Month Attrition. 43
Table 18. Partial Effects of Educational Credentials by 12-Month Attrition Periods. 44
Table 19. OLS Regression Results for AFQT and Educational Variables: 48-Month Attrition. 49
Table 20. OLS Regression Results for AFQT Only: 48-Month Attrition. 49
Table 21. OLS Regression Results for Educational Variables Only: 48-Month Attrition 50
Table 22. Logit Regression Results for AFQT and Educational Variables: 48-Month Attrition. 52
Table 23. Logit Regression Results using Matrix Columns: 12-Month Attrition. 69

Table 24. Logit Regression Results using Educational Tiers: 12-Month Attrition.. 70
Table 25. Logit Regression Results using Matrix Columns: 24-Month Attrition. 71
Table 26. Logit Regression Results using Educational Tiers: 24-Month Attrition.. 72
Table 27. Logit Regression Results using Matrix Columns: 36-Month Attrition. 73
Table 28. Logit Regression Results using Educational Tiers: 36-Month Attrition.. 74
Table 29. Logit Regression Results using Educational Variables: 12-Month Attrition. 75
Table 30. Logit Regression Results using Educational Variables: 24-Month Attrition. 76
Table 31. Logit Regression Results using Educational Variables: 36-Month Attrition. 77
Table 32. Predicted Probability of 48-Month Completion: Dropout3. 79
Table 33. Predicted Probability of 48-Month Completion: GED2.. 79
Table 34. Predicted Probability of 48-Month Completion: Cert2. 80
Table 35. Predicted Probability of 48-Month Completion: CollSem1.. 80
Table 36. Predicted Probability of 48-Month Completion: Adult1. 81
Table 37. Predicted Probability of 48-Month Completion: HSGrad1.. 81
Table 38. Predicted Probability of 48-Month Completion: Assoc1. 82
Table 39. Predicted Probability of 48-Month Completion: Bach1. 82

I. INTRODUCTION

A. BACKGROUND

A great deal of research has been amassed over the years showing the importance of educational attainment to military performance. Specifically, enlistees with higher levels of education tend to have lower first-term attrition rates.[1] Due to the growing variety of "citations, certificates, and degrees available from a growing array of institutions," a three-tiered classification system was formulated in the 1980s to better categorize the different general types of military applicants:[2]

- Tier I – Primarily traditional high school graduates and equivalents;
- Tier II – Alternative high school credential-holders (including recipients of General Educational Development (GED) certificates, Certificates of Attendance, and Correspondence School diplomas); and
- Tier III – Non-high school graduates (high school dropouts).[3]

This three-tiered classification system, and the research behind it, is the basis for the current Recruit Quality Matrix that the Navy uses to screen applicants for

---

[1] First-term attrition is defined as the failure to complete the initial term of enlistment—typically four years.

[2] Janice H. Laurence, Peter F. Ramsberger, and Jane Arabian, Education Credential Tier Evaluation, FR-EADD-96-19 (Alexandria, VA: Human Resources Research Organization, 1996), 9.

[3] Since the formulation of the three-tiered system, special interest lobbying has led to changes in the original system design. For example, adult education diploma recipients were included in Tier I in the 1980s, and home school graduates were added to Tier I in the 1990s. Both groups were originally considered Tier II, based on comprehensive analyses.

enlistment. The Navy's Recruit Quality Matrix is shown in Figure 1.

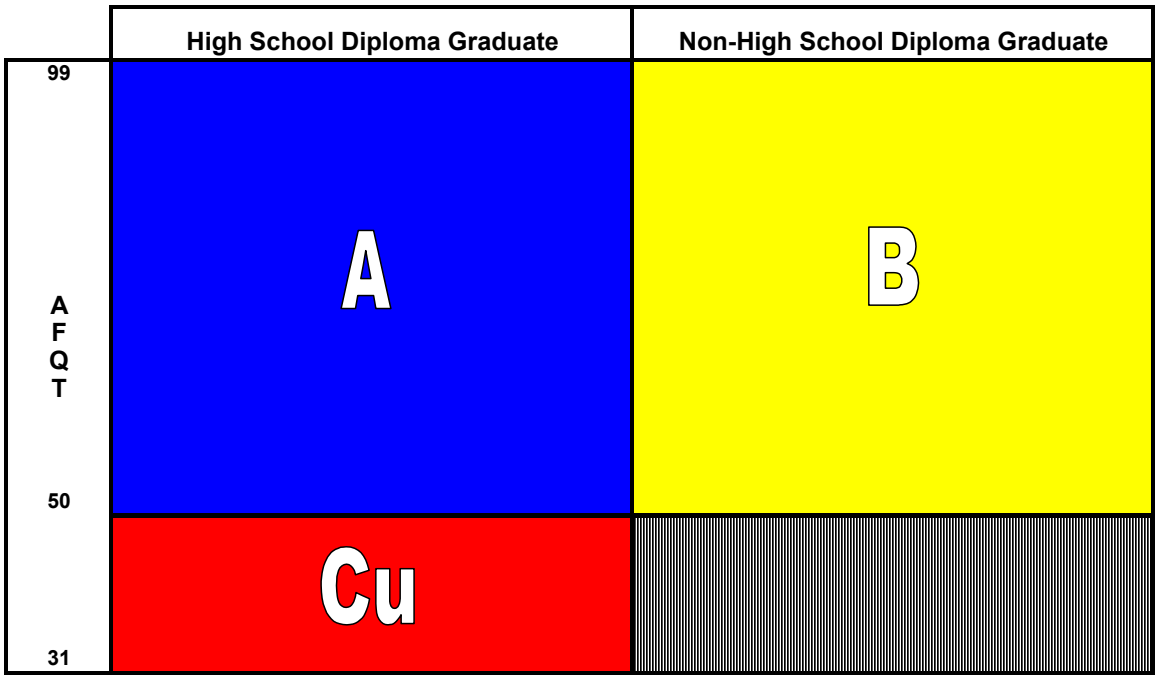

Figure 1. Navy's Recruit Quality Matrix
Source: After Commander, Navy Recruiting Command, 2003.

As seen in Figure 1, an applicant's educational status is cross-referenced with his or her Armed Forces Qualification Test (AFQT) score to determine placement in a cell.[4] Only A-cell, B-cell, and Cu-cell applicants are eligible for enlistment, and only with corresponding AFQT scores, as displayed in the matrix. (For example, non-high school diploma graduates, Cell B, are required to score 50 or above on the AFQT.)

Of persons eligible for enlistment, traditional high school graduates (in A-Cell and Cu-Cell) have significantly lower first-term attrition rates than do Tier II and Tier

[4] The AFQT score is a measure of general trainability derived from the Armed Services Vocational Aptitude Battery (ASVAB).

III applicants (in B-Cell). A recent Center for Naval Analyses (CNA) study of fiscal year 1990-2002 Navy enlisted cohorts revealed that A-Cell and Cu-Cell enlistees had significantly lower bootcamp attrition rates (11.1 percent and 15.0 percent, respectively) than B-Cell sailors (21.7 percent).[5] Other studies have shown that the same general trend applies for all 12-month, 24-month, 36-month, and 48-month attrition as well. Because of this phenomenon, recruiting efforts tend to focus primarily on Tier I applicants. In fiscal year 2003, 92 percent of all Navy recruits were in Tier I.[6] Consequently, the Navy accepts very few Tier II and III applicants. When considered, these non-traditional high school graduates must usually score significantly higher than their Tier I counterparts on the enlistment test. Additionally, they are subject to additional screening with the High Performance Profile Predictor (HP3) model, where compensatory factors such as employment history and motivation for military service are considered to ensure that only the "best qualified" non-traditional high school graduates are allowed to enlist.[7]

However, these general tiers include heterogeneous groupings of individuals with varied backgrounds. It is unrealistic to believe that all personnel within Tier II, for instance, behave the same and achieve the same levels of military "success." If there are significant differences

---

[5] Center for Naval Analyses, Attrition and Reenlistment of First-Term Sailors, (Alexandria, VA: CNA, 2003).

[6] Commander, Navy Recruiting Command, Requirements Drivers, (Millington, TN: CNRC, 2003).

[7] Commander, Navy Recruiting Command, Navy Recruiting Manual-Enlisted (COMNAVCRUITCOMINST 1130.8F) (Millington, TN: CNRC, 2002), 2-50.

within these groups, omission of these details may limit the effectiveness of the existing Recruit Quality Matrix in predicting attrition. A more detailed screening tool, one that breaks out the subgroups in more detail, could produce benefits in two possible ways:

- A subgroup currently included in Tier I (such as adult education diploma recipients) might actually have a significantly higher attrition rate than the average for Tier I. By moving it out of Tier I, resources and efforts could be devoted to persons with lower attrition rates (traditional high school graduates), resulting in a lower overall level of attrition (fewer "false positives"); and

- A subgroup currently included in Tier II (such as GED recipients) might actually have a lower attrition rate than other subgroups in the second tier. By moving it out of Tier II, the pool of potential "high quality" recruits could be increased (fewer "false negatives").

If the myriad of educational credentials results in more than three statistically different groupings (more than three different levels of military success), then a three-tiered matrix may be a less effective screening device than one with a lower level of aggregation.

B. PURPOSE AND BENFITS OF THE STUDY

The primary purpose of this study is to assess the suitability of the existing Recruit Quality Matrix by analyzing the first-term attrition rates of enlisted personnel with different educational credentials at the time of entry into the Navy. If the attrition patterns do not support the structure of the current matrix, an alternative screening tool might help the Navy reduce attrition and better focus its recruiting efforts.

C. ORGANIZATION OF THE THESIS

This thesis contains six chapters. Chapter I provides background and a general overview of the area of analysis. Chapter II reviews literature and studies relating to attrition and educational credentials. Chapter III describes the results of tests aimed at assessing the utility of the current Recruit Quality Matrix, using a database of Navy recruits (fiscal year 1998 through 2003) to analyze bootcamp attrition rates. Chapter IV has a similar focus, but it contains results of an analysis of 12-month, 24-month, 36-month, and 48-month attrition trends for Navy enlistees (fiscal year 1989 through 1997). Chapter V presents a potential screening tool that incorporates findings from the data analysis. Chapter VI offers conclusions, and Chapter VII ends with recommendations based on this study.

THIS PAGE INTENTIONALLY LEFT BLANK

II. LITERATURE REVIEW

The "education differential"—that is, different minimum aptitude requirements for different levels of educational attainment—was first introduced in the Navy in 1965.[8] (The Air Force had experimented with it as far back as 1950, requiring high school dropouts to have a higher minimum AFQT score than traditional high school graduates.[9]) Various iterations of the education differential have been in place ever since, with the Armed Services Vocational Aptitude Battery (ASVAB) becoming the sole military entrance exam for all services in 1976.[10]

A. HISTORICAL REVIEW OF ATTRITION RESEARCH BY APTITUDE AND EDUCATION LEVEL

Although many variables have been linked to early enlisted attrition over the years, level of education has proven to be one of the most significant and consistent predictors. As stated in a 1978 report by the Office of the Assistant Secretary of Defense, "possession of a high school diploma is the best single measure of a person's potential for adapting to life in the military."[11]

---

[8] M. J. Eitelberg, J. H. Laurence, L. S. Perlman, and B. K Waters, Screening for Service: Aptitude and Education Criteria for Military Entry (Alexandria, VA: Human Resources Research Organization, 1984), 144.

[9] M. J. Eitelberg, A Preliminary Evaluation of Education Standards for Military Enlistment (Monterey, CA: Naval Postgraduate School, 1983), 1.

[10] Eitelberg et al., 145.

[11] Department of Defense, America's Volunteers, (Washington, D. C.: Office of the Assistant Secretary of Defense [Manpower, Reserve Affairs, and Logistics], 1978), 30.

Research shows that aptitude is also an important predictor of military success. According to Laurence:

> Aptitude test scores gauge the ability to absorb military training and perform the necessary job skills, while education level is used mostly as an index of social adjustment and to predict the likelihood of successfully completing a full term of service.[12]

Taken together, these two variables form the basis of the Navy's current Recruit Quality Matrix.

Flyer was the first to identify the relationship between level of education and attrition in 1959. He concluded that "the most dramatic way to reduce unsuitability discharge would be to require a high school diploma from all Air Force recruits."[13] In 1977, Cooper showed that the military performance and behavior of high school graduates were superior to that of GED recipients and high school dropouts, even when controlling for factors such as aptitude level.[14] Four years later, Griffin looked at first-term enlisted attrition trends from 1965 to 1977 and also found that high school graduates were more likely than non-high school graduates to complete a first-term of enlistment. Additionally, she showed that individuals with

---

[12] Janice H. Laurence, Education Standards for Military Enlistment and the Search for Successful Recruits, FR-PRD-84-4 (Alexandria, VA: Human Resources Research Organization, 1984), 2-3.

[13] Eli S. Flyer, Factors Relating to Discharge for Unsuitability Among 1956 Airman Accessions to the Air Force, WADC-TN-59-201 (Lackland AFB, TX: Personnel Laboratory, Wright Air Development Center, 1959), 15.

[14] R. V. L. Cooper, Military Manpower and the All-Volunteer Force, R-1450-ARPA (Santa Monica, CA: RAND Corporation, 1977).

higher AFQT scores had higher first-term completion rates than those with lower scores.[15]

A 1982 study by Elster and Flyer arrived at many of the same conclusions about the military "success" of enlistees with different educational credentials, using performance measures such as attrition, retention, assignment, and advancement.[16] As shown in Table 1, Elster and Flyer used simple descriptive statistics to show Navy attrition percentages during the first three years of active duty. The authors concluded that Navy attrition rates for high school graduates were approximately one-half the loss rates for either non-high school graduates or GED recipients, with the rates for GED recipients (47.5 percent) being more similar to that of non-high school graduates (54.9 percent) than that of high school graduates (26.2 percent).[17] It should also be noted that these patterns were similar across all military services.

In 1984, Buddin corroborated that non-high school graduates had early attrition rates approximately twice that of traditional high school graduates. He concluded that, "for all services, not having a high school diploma is a major determinant of early attrition."[18] He also noted what Griffin wrote three years earlier, namely that AFQT scores are inversely correlated to early attrition rates.

---

[15] Patricia Griffin, First Term Attrition Severity Index For U.S. Navy Ratings, Master's Thesis (Monterey, CA: Naval Postgraduate School, 1981), 13-22.

[16] Richard S. Elster and Eli Flyer, A Study of Relationships Between Educational Credentials and Military Performance Criteria (Monterey, CA: Naval Postgraduate School, 1982).

[17] Ibid., II.24-II.25.

[18] Richard Buddin, Analysis of Early Military Attrition Behavior, R-3069-MIL (Santa Monica, CA: RAND Corporation, 1984), 47-50.

Table 1. Navy Attrition Rates (Percent) Prior to Completion of the First Three Years of Active Duty, Fiscal Years 1973 through 1976 Non-Prior Service Male Accessions

ATTRITION	NON-HS GRAD	GED	HS GRAD
Medical	2.9	3.1	3.5
Hardship	.4	.2	.4
Performance	46.4	38.8	18.7
Other	5.2	5.4	3.6
Total:	**54.9**	**47.5**	**26.2**

Source: After Elster and Flyer, A Study of Relationships Between Educational Credentials and Military Performance Criteria (Monterey, CA: Naval Postgraduate School, 1982), II.24 – II.25.

In a 1992 study, Cooke and Quester arrived at virtually the same conclusions. They found that high school graduates had a first-term attrition rate of only 29 percent (actually reported as a 71-percent completion rate), while alternate credential-holders and high school dropouts had attrition rates significantly higher—53 percent and 57 percent, respectively.[19] From these observed patterns, that more secondary education tends to correspond with lower attrition, one might conclude that post-secondary education would lead to even lower attrition. Research does, in fact, support that notion. In 1998, Golfin found that college-educated recruits "historically have even lower first-term attrition than those with a high school degree."[20]

[19] Timothy W. Cooke and Aline O. Quester, "What Characterizes Successful Enlistees in the All-Volunteer Force: A Study of Male Recruits in the U.S. Navy," Social Science Quarterly, vol. 73, no. 2 (June 1992): 241.

[20] Peggy A. Golfin, A Summary of Navy Recruiting Efforts in Community Colleges in FY1997 (Alexandria, VA: CNA, 1998), 2.

B. EDUCATION TRENDS

The number and type of alternate high school credentials have increased considerably since the 1950s, when the link between educational attainment and attrition was first identified. This trend has complicated the process of screening applicants for military service, since many of the new credentials do not fit easily within current service categories.[21]

It would be easy to discount many of the newer credentials as "cheap substitutes" for the traditional high school diploma, with little or no real value. Eitelberg captured that sentiment by imagining how the Scarecrow, from the Wizard of Oz (1939), might enlist on the merits a special diploma that was bestowed upon him by the Wizard.[22] The Office of the Secretary of Defense captured this fantastic scenario in a briefing used to promote the adoption of new educational standards. As seen in Figure 2, the Scarecrow did not need a brain to enlist; he had a diploma.

---

[21] Janice H. Laurence, Secondary Education Credentials: A Military Enlistment Policy Dilemma, FR-PRD-83-22 (Alexandria, VA: Human Resources Research Organization, 1983), 40.

[22] Eitelberg et al., 120.

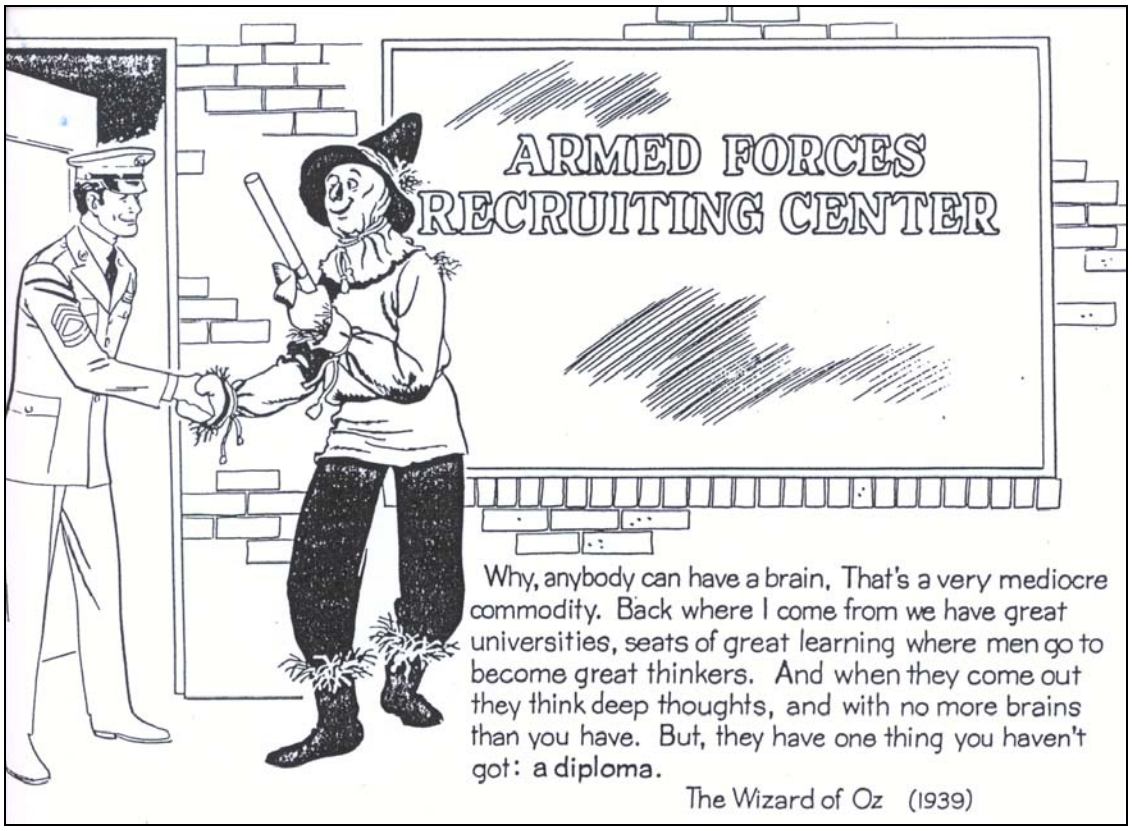

Figure 2. The Scarecrow Joins the Army
Source: From Office of the Secretary of Defense, Directorate for Accession Policy, 1984.

Because of the prevalence of alternative credentials in today's society, however, policymakers may need to reconsider old paradigms and try to exploit the growing personnel pool that alternative-credential holders represent. The growth in different types of alternate credentials has led to greater numbers of alternate credential holders. According to the U.S. Department of Education's National Center for Education Statistics (NCES), the number of GEDs issued over the past 30 years has almost tripled.[23] This pattern is illustrated in Figure

[23] National Center for Education Statistics, Table 106: GED Test Takers, and Number and Distribution of Credentials Issued, by Age: 1971 to 2001, [report on-line] (Washington, D. C.: Department of Education, 2004, accessed 05 February 2004): available from http://nces.ed.gov/programs/digest/d02/tables/dt106.asp; Interent.

3. In California alone, 343,763 young adults were enrolled in adult education classes during the 1999-2000 school year. More specifically, in the Los Angeles area, approximately 13 percent of all high school-age students were enrolled in some form of alternative education program during that year.[24]

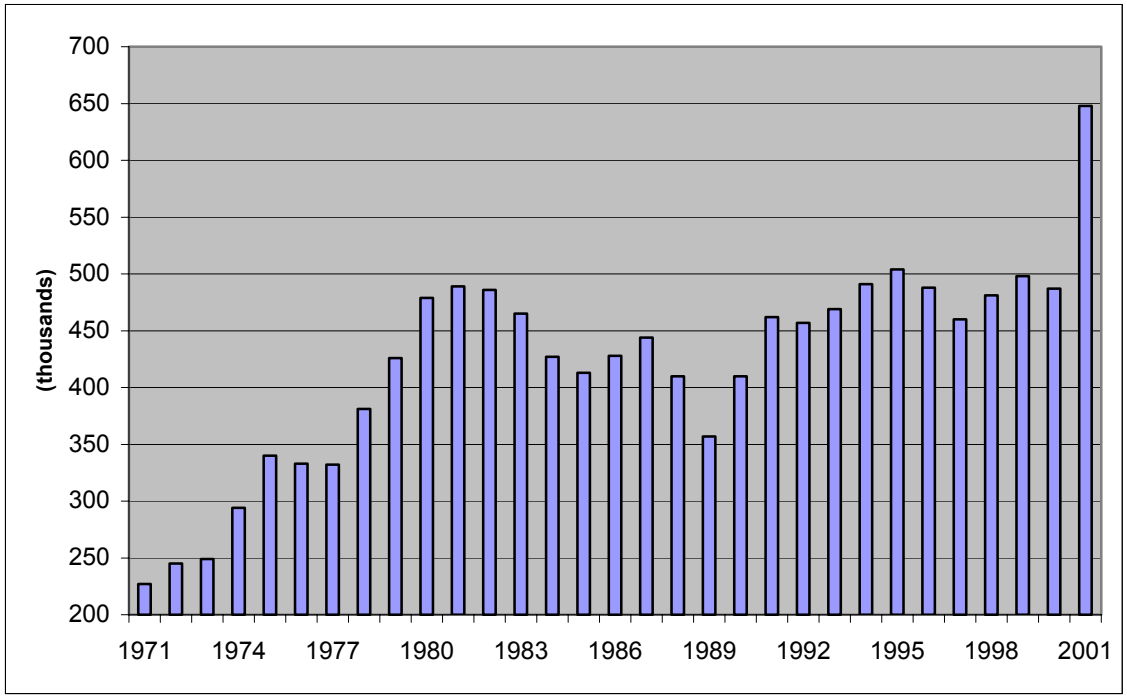

Figure 3. GEDs Granted, 1971 through 2001
Source: After NCES, Table 106: GED Test Takers, and Number and Distribution of Credentials Issued, by Age: 1971 to 2001, http://nces.ed.gov.

As the percentage of high school graduates with alternative credentials increases nationwide, the percentage of graduates with a traditional high school diploma declines. If recruiting policy is not adjusted, and if the current recruit screening tools are not updated to

[24] Robert J. Gaines, Impact of Alternative Secondary School Education on Recruiting (Los Angeles, CA: Navy Recruiting District Los Angeles, 2003), 1.

account for the expanded number of alternate credentials, recruiting may become more difficult.

III. ANALYSIS OF NAVY BOOTCAMP ATTRITION

First-term attrition is one of the most commonly used measures of military "success" in studies by manpower analysts. Attrition during initial training, called bootcamp, is an important subset of first-term attrition that merits consideration, because first-term attrition trends can be extrapolated from bootcamp attrition trends. Further, attrition during initial training accounts for about one-third of the attrition that occurs within the first four years of service.[25]

Additionally, bootcamp attrition is very costly to the Navy. According to Commander, Navy Recruiting Command (CNRC), in fiscal year 2001, the average cost-per-accession was $10,176. With an annual Recruit Training Center (RTC) population of about 50,000 recruits, a one-percentage-point increase in attrition (approximately 500 recruits) would result in an additional cost of over $5 million.[26] That figure does not include training costs. When attrition occurs after training has been invested in a recruit, the financial loss to the Navy increases dramatically.

A. DATA

The data set used for this thesis was constructed from CNRC's Personalized Recruiting for Immediate and Delayed Enlistment (PRIDE) database; it contains active-duty

---

[25] David L. Alderton, Selection and Classification for Enlisted Service (Millington, TN: Navy Personnel Research, Studies, and Technology (NPRST), 2002), 4. It should be noted that initial training occurs at the Recruit Training Center (RTC), located in Great Lakes, Illinois.

[26] Aline Quester, Bootcamp Attrition Rates: Predictions for FY99 (Alexandria, VA: Center for Naval Analyses (CNA), 1999), 2; and Commander, Navy Recruiting Command, 2003.

observations from fiscal years 1998 through 2003. Six years worth of data were collected to ensure that there would be adequate sample sizes for those possessing some of the more uncommon educational credentials, such as adult education diplomas and home school diplomas. Larger sample sizes will increase the precision of multivariate point estimates.

The source database contains 286,274 observations. However, to promote the homogeneity of the data set, recruits with an 8-year term of enlistment were deleted (n=11,561). Additionally, recruits entering the Navy as an E-4 or above were not considered and observations with missing or unreliable data were deleted. These restrictions result in a data set with 261,051 observations for analysis. Statistical Analysis System (SAS) software was used to process and analyze the data.

B. METHODOLOGY

The six years of enlisted cohort data were used to analyze attrition patterns of various groups of educational credential holders. CNRC provided an "RTC attrition" variable for each observation; it is defined as the failure to complete initial recruit training at RTC Great Lakes.

C. VARIABLES

The variables of primary interest for this analysis are AFQT score and educational credential, because these are the two variables used by CNRC to determine initial enlistment eligibility. Nine education variables are present in the data set in sufficient numbers for meaningful statistical analysis—one Tier III, one Tier II, and seven Tier I education variables. They are Dropout3, GED2, NGYCP1, HomeSchool1, CollSem1, Adult1, HSGrad1,

Assoc1, and Bach1. See Table 2 for a description and Table 8 for descriptive statistics for each education variable.

Table 2. Educational Credentials[a]

Variable	Variable Name	Variable Description (and Tier Classification)
High School Dropout	Dropout3	One who does not possess any form of a high school diploma (Tier III)
GED Recipient	GED2	One who possesses a non-traditional, test-based equivalency diploma (Tier II)
National Guard Youth Challenge Program Graduate[b]	NGYCP1	One who possesses a GED and participated in the NGYCP (Tier I)
Home School Graduate	HomeSchool1	One who possesses a non-traditional, home school diploma (Tier I)
Completed One College Semester	CollSem1	One who possesses some form of a non-traditional high school diploma, and completed at least one semester of college-level credit (Tier I)
Adult School Graduate	Adult1	One who possesses a non-traditional high school diploma from an adult education or continuation program (Tier I)
High School Graduate	HSGrad1	One who possesses a traditional high school diploma as the result of 12 years of classroom instruction (Tier I)
Associate's Degree Holder	Assoc1	One who possesses a 2-year college degree (Tier I)
Bachelor's Degree Holder	Bach1	One who possesses a 4-year college degree (Tier I)

Source: After Commander, Navy Recruiting Command, 2003.

[a] Other groups of alternate educational credential holders (like Certificate of Attendance Recipients and Correspondence School Diploma Recipients) were omitted because sample sizes were too small.

[b] The National Guard Youth Challenge Program (NGYCP) is a program for at-risk youth that combines quasi-military training with GED certification.

Other control variables were added to improve model specification. These variables included age, gender, race, marital and family status, entry pay grade, time in the Delayed Entry Program (DEP), school guarantee, enlistment bonus, and term of enlistment. Descriptions of these control variables appear in the next section, in Table 4.

D. RESULTS

This section presents the results of bootcamp attrition analysis by AFQT and educational credentials.

1. Bootcamp Attrition Trends

In her analysis of bootcamp attrition rates, Quester observed that bootcamp attrition doubled from fiscal year 1990 (approximately 8 percent) to fiscal year 1998 (over 16 percent). Quester felt that this increase was somewhat artificial; in 1989, Admiral Jeremy Boorda, then the Chief of Naval Operations, implemented a "discharge moratorium for the first three weeks of bootcamp."[27] Since much of bootcamp attrition occurs in the first three weeks, it was believed that this moratorium artificially lowered what would have been a higher rate of attrition, similar to rates that occurred after the moratorium was lifted.[28]

Picking up where Quester's research ended, this analysis shows a steady decline in bootcamp attrition rates from fiscal year 1998 to fiscal year 2003 (see Figure 3), which coincides with a decrease in the proportion of Tier II and Tier III recruits in the Navy over that same time

[27] Quester, 4.

[28] Interestingly enough, however, this moratorium (resulting in lower bootcamp attrition rates in fiscal years 1990 and 1991) was not offset by higher fleet attrition during the first-terms of the affected sailors. Post-bootcamp attrition, as a percentage of total first-term attrition, remained constant through fiscal year 1995.

period. This phenomenon suggests that the higher attrition rates in the late 1990s, not the lower rates in the early 1990s, are the aberration.

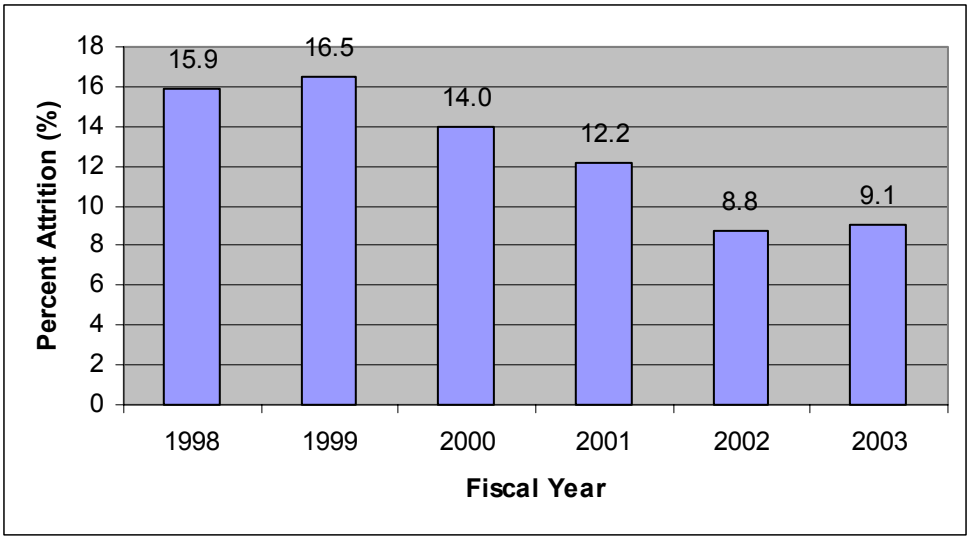

Figure 4. Bootcamp Attrition Rates (Percent), Fiscal Years 1998 through 2003
Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.

2. Attrition by Educational Tier and Matrix Column

This analysis shows the differences in bootcamp attrition rates between Tier I recruits (referred to as High School Diploma Graduates [HSDGs], in the first column of the Recruit Quality Matrix) and Tier II and III recruits (grouped together as Non-High School Diploma Graduates [NHSDGs], in the second column of the Recruit Quality Matrix). (See Figure 1 for a graphic representation of these groupings.) Not surprisingly, Column I (Tier I) recruits have lower bootcamp attrition rates than their Column II (Tiers II and III) counterparts. As Table 3 shows, attrition rates during the fiscal year 1998 to 2003 period for Tier I recruits were about 8 points (or 40 percent) lower than for Tier II and Tier III recruits.

Table 3. Bootcamp Attrition, Fiscal Years 1998 through 2003

Variable	**Number in Data Set(N)**	**Attrition Rate (%)**
Column I/*Tier I*	239,588	12.1
Column II	21,463	20.6
Tier II	*12,084*	*20.6*
Tier III	*9,379*	*20.6*
Total	**261,051**	**12.8**

Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.

Using Maximum Likelihood Estimation (MLE), a logit model was used to more thoroughly analyze these relationships and to test for statistical significance. Based on the literature review conducted in Chapter II, variables that were identified as having significant effects on attrition (that could be constructed from the available data set) were used in the model specified below. Two models were constructed—a "column" model and a "tier" model. For the tier model, the Column2 variable was replaced with Tier2 and Tier3 dummy variables. Also, for both models, the "base case" was a Tier I, single, white, 19-year old male with no dependents, entering the Navy with a four-year commitment, as an E-1 with a school guarantee but no enlistment bonus, with an AFQT of 59 and having been in the DEP for 117 days. The variables are described in Table 4:

AttriteBC = B0 + B1(Age) + B2(Female) + B3(APINA) + B4(Black) + B5(Hispanic) + B6(MultiRace) + B7(Married) + B8(Depends) + B9(AFQT2) + B10(E2) + B11(E3) +B12(DEPDays) + B13(DepSq) + B14(Column2) + B15(NSG) + B16(Bonus) + B17(Term5) + B18(Term6) + μ.

Table 4. Variable Descriptions and Descriptive Statistics

Variable	Description	Mean	Std Dev	Min	Max
AttriteBC	= 1 if "Attrited" during Bootcamp, 0 otherwise	.1360	.3427	0	1
Female	= 1 if Female, 0 otherwise	.1874	.3902	0	1
APINA	= 1 if Asian, Pacific Islander, or Native American, 0 otherwise	.0912	.2879	0	1
Black	= 1 if Black, 0 otherwise	.2423	.4285	0	1
Hispanic	= 1 if Hispanic, 0 otherwise	.1741	.3791	0	1
MultiRace	= 1 if Multiracial, 0 otherwise	.0125	.1113	0	1
Married	= 1 if Married, 0 otherwise	.0165	.1274	0	1
Dependents	= 1 if Dependents other than Spouse, 0 otherwise	.0043	.0657	0	1
E2	= 1 if Entered as an E-2, 0 otherwise	.0145	.1196	0	1
E3	= 1 if Entered as an E-3, 0 otherwise	.0145	.1195	0	1
Column2	= 1 if Tier II or III, based on educational credential, 0 otherwise	.0915	.2884	0	1
Tier2	=1 if Tier II, 0 otherwise	.0384	.1921	0	1
Tier3	=1 of Tier III, 0 otherwise	.0531	.2243	0	1
NSG	= 1 if Enlisted without a School Guarantee, 0 otherwise	.3893	.4876	0	1
Bonus	= 1 if Received an Enlistment Bonus, 0 otherwise	.2240	.4169	0	1
Term5	= 1 if 5-year commitment, 0 otherwise	.2884	.4530	0	1
Term6	= 1 if 6-year commitment, 0 otherwise	.1735	.3787	0	1
Age	Age in Years (17-34)	19.72	2.668	17	34
AFQT2	AFQT Percentile (31-99)	52.26	16.05	31	99
DEPDays	Number of Days in DEP	114.0	107.3	0	540
DEPSq	Number of Days Squared	24502	36255	0	291,600

Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.

* For this model, the "base case" was the "average" recruit—a Tier I, single, white, 19-year old male with no dependents, entering the Navy with a four-year commitment, as an E-1 with a school guarantee but no enlistment bonus, with an AFQT of 59 and having been in the DEP for 117 days.

In this section, two models were constructed to analyze bootcamp attrition: a “column” model and a “tier” model. In the “tier” model, the Column2 variable was replaced with two dummy variables representing Tier2 and Tier3. Both models were validated to ensure suitability. In each case, the validation included a logit model specification that included only AFQT and educational categories (tiers and columns), and a second model that included these and all of the other independent variables described in Table 4.

Because Column II recruits make up such a small proportion of the total data set (less than 9 percent), and because Tier II and III applicants have such similar attrition rates, the regression results from both models, presented in Table 5 and Table 6, are virtually identical. For both validation analyses, the AFQT and educational variables retained their significance when the additional independent variables were added, and the model maximum rescaled R-squared values increased from 0.0146 to 0.0341.

Standard R-squared values obtained from MLE are usually quite similar to the R-squared values obtained from fitting a linear probability model (Ordinary Least Squares [OLS] regression). However, OLS is based on minimizing the sum of the squared residuals, and the OLS R-squared values are a measure of the proportion of variance explained by the independent variables. In MLE, standard R-squared values do not have the same interpretation.[29] Therefore, to derive a measure of goodness of fit that has a similar (but not exact) meaning, a ‘pseudo’ R-squared is calculated by

[29] Paul D. Allison, Logistic Regression: Using the SAS System (Cary, NC: SAS Institute, Inc, 2001), 57.

using the likelihood ratio that SAS generates (displayed in Tables 5 and 6). That pseudo R-squared value is adjusted so that the upper bound is equal to one, and the result is the maximum rescaled R-squared value, which is also displayed in Tables 5 and 6.

Table 5. Logit Regression Results using Matrix Columns

Variable	**Estimate**	**Std Error**	**P-Value**
Intercept	-1.4635	0.0518	<.0001
Age	0.0225	2.18E-3	<.0001
Female	0.3929	0.0147	<.0001
APINA	-0.2934	0.0214	<.0001
Black	-0.3153	0.0160	<.0001
Hispanic	-0.3990	0.0180	<.0001
MultiRace	-0.6009	0.0677	<.0001
Married	0.1401	0.0462	0.0025
Depends	-0.1648	0.0917	0.0724
AFQT2	-0.0106	4.24E-4	<.0001
E2	-0.2011	0.0492	<.0001
E3	-0.2679	0.0462	<.0001
DEPDays	-3.73E-3	2.02E-4	<.0001
DEPSq	6.04E-6	6.01E-7	<.0001
Column2	**0.5814**	**0.0190**	**<.0001**
NSG	0.0649	0.0173	0.0002
Bonus	-0.0738	0.0145	<.0001
Term5	0.0409	0.0161	0.0112
Term6	0.0547	0.0231	0.0180
Max Rescaled R-Square	0.0341		
Likelihood Ratio	4803.5		
Pr>ChiSq	<0.0001		
N	261,051		

Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.
* All results are significant at α=0.10.

Table 6. Logit Regression Results using Educational Tiers

Variable	**Estimate**	**Std Error**	**P-Value**
Intercept	-1.4638	0.0519	<.0001
Age	0.0225	2.19E-3	<.0001
Female	0.3929	0.0147	<.0001
APINA	-0.2934	0.0214	<.0001
Black	-0.3153	0.0160	<.0001
Hispanic	-0.3990	0.0180	<.0001
MultiRace	-0.6010	0.0677	<.0001
Married	0.1400	0.0462	0.0025
Depends	-0.1648	0.0917	0.0725
AFQT2	-0.0107	4.24E-4	<.0001
E2	-0.2011	0.0492	<.0001
E3	-0.2680	0.0462	<.0001
DEPDays	-3.73E-3	2.02E-4	<.0001
DEPSq	6.04E-6	6.01E-7	<.0001
Tier2	**0.5793**	**0.0241**	**<.0001**
Tier3	**0.5841**	**0.0276**	**<.0001**
NSG	0.0649	0.0173	0.0002
Bonus	-0.0735	0.0146	<.0001
Term5	0.0410	0.0162	0.0111
Term6	0.0549	0.0232	0.0179
Max Rescaled R-Square	0.0341		
Likelihood Ratio	4803.5		
Pr>ChiSq	<0.0001		
N	261,051		

Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.
* All results are significant at α=0.10.

Results for the control variables were as expected, and they generally reinforced previous attrition research. As seen in Tables 5 and 6, all other factors being held constant, the variables that resulted in higher attrition rates were being older, being female, being married, enlisting for a term longer than four years, and enlisting with no school guarantee. Being Asian, Pacific Islander, Native American, black, Hispanic, or multiracial, however, resulted in a lower attrition rate, as did having dependents (other than a spouse), enlisting at a higher pay grade, and receiving an enlistment bonus. Time in DEP had the effect observed by Matos in his 1994 Naval Postgraduate School (NPS) thesis; attrition reduced up to a certain "optimal DEP length," then increased beyond that point.[30]

Additionally, the estimates of the primary independent variables (AFQT score and educational status) were significant and as predicted. As AFQT score increased, attrition decreased. And, possessing a "lower" educational credential than a Tier I recruit resulted in a higher attrition rate. Table 7 shows the partial effects for each of the primary variables.

Table 7. Partial Effects of AFQT and Educational Variables

Variable	Partial Effects from Table 5	Partial Effects from Table 6
AFQT	-0.0011	-0.0011
Column 2	0.0748	
Tier 2		*0.0744*
Tier 3		*0.0752*

Source: Derived from Results in Tables 5 and 6.
* All results are significant.

[30] Rafael Matos, U.S. Navy's Delayed Entry Program: Effects of Its Length on DEP Loss and First-Term Attrition, Master's Thesis (Monterey, CA: Naval Postgraduate School, 1994), 12-13.

According to Table 7, scoring 10 points higher on the AFQT would result in a 1.1 percentage-point decrease in the probability of attrition, holding all other variables constant. And, being a NHSDG in Column II would result in an attrition rate 7.5 percentage points higher than that of a HSDG. Or, more specifically, Tier II and Tier III recruits would be expected to experience attrition at rates 7.4 and 7.5 percentage points higher than Tier I recruits, respectively, all else being equal.

3. Attrition by Educational Credential

Despite the expected results noted above, and the seemingly high predictive ability of educational tiers and matrix columns as predictors of military "success" (bootcamp attrition, in this case), the general groupings are not as refined as they could be. In each case, the estimated coefficients yield the average effect of numerous specific educational credentials. Further analysis shows that various educational credentials (within Tier I) result in significantly different attrition rates. So, although Tier I recruits generally exhibit lower attrition rates than do Tier II or Tier III recruits, some non-traditional educational credential categories within Tier I actually have an average rate of attrition that is more reflective of the average rates in Tiers II and III.

Table 8 contains tabulations of bootcamp attrition rates by the individual educational categories. As seen here, although educational categories in Tiers II and III have higher associated attrition rates than those in Tier I, the rates for educational categories grouped in Tier I vary from a low of 8.7 percent (Bachelor's Degree) to a high of 23.4 percent (home school). Additionally, home

school graduates, assigned to Tier I, actually have a higher attrition rate than GED recipients (Tier II) and high school dropouts (Tier III). Furthermore, non-traditional high school graduates with one college semester (Tier I) tend to have an attrition rate closer to Tier II and III recruits than to other Tier I recruits. This suggests, perhaps, that aggregating educational categories into tiers and columns is not as effective in predicting military bootcamp attrition as when the model includes each separate education cateory.

Table 8. Navy Bootcamp Attrition Rates (Percent) by Educational Credential, Fiscal Years 1998 through 2003

Credential (Tier)	Number in Data Set	Attrition Rate (%)
Dropout (III)	9,379	20.6
GED (II)	12,084	20.6
Home School (I)	2,124	23.4
One Coll Sem (I)	8,715	17.3
Adult School (I)	8,403	15.4
NGYCP (I)	1,329	14.5
HS Grad (I)	214,264	11.7
Assoc Degree (I)	1,776	10.9
Bach Degree (I)	2,977	8.7
Total	**261,051**	**12.8**

Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.

A logit model was used to analyze the results after breaking out educational attainment into the various credentials. The same statistical model was used, except that dummy variables for the various educational categories described in Table 8 were used in place of the tier and column variables. This model was also validated to ensure suitability and, again, the AFQT and educational variables retained their significance when the additional independent

variables were added; the maximum rescaled R-squared values increased from 0.0176 to 0.0365. The regression results are presented in Table 9.

As seen in Table 9, all of the Tier II and III variables, as well as the non-traditional Tier I variables, had positive coefficients, indicating higher attrition rates than the base case (traditional high school graduate), holding other variables constant. Post-high school Tier I variables (assoc1 and bach1) had negative coefficients, indicating lower attrition rates.

The partial effects in Table 10 were derived from the logit coefficient estimates in Table 9. Multiplied by 100, these partial effects represent the percentage-point difference in attrition for each educational category as compared to the base case (traditional high school graduate). For example, the bootcamp attrition rate for a high school dropout in this data set was approximately 8 percentage points higher than that of a traditional high school graduate, while the bootcamp attrition rate for a Bachelor’s Degree-holder was about 3 percentage points lower than that of a traditional high school graduate with no post-secondary education, all other factors being held constant.

Table 9. Logit Regression Results for Educational Variables: Bootcamp Attrition

Credential (Tier)	Estimate	Std Error	P-Value
Intercept	-1.5643	0.0534	<.0001
Age	0.0237	2.25E-3	<.0001
Female	0.4044	0.0147	<.0001
APINA	-0.2916	0.0214	<.0001
Black	-0.3062	0.0161	<.0001
Hispanic	-0.3981	0.0180	<.0001
MultiRace	-0.5920	0.0678	<.0001
Married	0.1314	0.0463	0.0045
Dependents	-0.1644	0.0918	0.0734
AFQT	-0.0100	4.27E-4	<.0001
E2	-0.2174	0.0493	<.0001
E3	-0.2062	0.0471	<.0001
DEPDays	-3.66E-3	2.02E-4	<.0001
DEPSquared	6.08E-6	6.01E-7	<.0001
NSG	0.0673	0.0173	<.0001
Bonus	-0.0822	0.0146	<.0001
Term5	0.0364	0.0162	0.0245
Term6	0.0599	0.0232	0.0098
Dropout (III)	**0.6164**	**0.0277**	**<.0001**
GED (II)	**0.6148**	**0.0243**	**<.0001**
Home School (I)	**0.6470**	**0.0524**	**<.0001**
One Coll Sem (I)	**0.3521**	**0.0297**	**<.0001**
Adult School (I)	**0.2595**	**0.0314**	**<.0001**
NGYCP* (I)	**0.1280**	**0.0788**	**0.1046**
Assoc Degree* (I)	**-0.1261**	**0.0782**	**0.1066**
Bach Degree (I)	**-0.3106**	**0.0685**	**<.0001**
Max Rescaled R-Square	0.0365		
Likelihood Ratio	5148.7		
Pr>ChiSq	<0.0001		
N	261,051		

Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.
* Not statistically significant.

Table 10. Partial Effects of Educational Credentials

Credential (Tier)	Partial Effect
AFQT	-0.0010
Dropout (III)	0.0785
GED (II)	0.0783
Home School (I)	0.0833
One Coll Sem (I)	0.0407
Adult School (I)	0.0290
NGYCP* (I)	0.0136
Assoc Degree* (I)	-0.0121
Bach Degree (I)	-0.0278

Source: Derived from results in Table 9.
*Not statistically significant.

4. Summary of Results from CNRC Data Analysis

The significant variation in attrition rates among various educational credential holders leads to the conclusion that the aggregated columns and tiers do not predict bootcamp attrition as precisely as the individual educational credentials. Table 10 shows that the attrition rate for some categories in Tier I (home school graduates) is nearly five times higher than for other categories (NGYCP) in Tier I. This is also supported by the fact that the maximum rescaled R-squared values for the aggregated models are 0.0341; when the educational credentials are broken out separately, the R-squared value increases to 0.0365, indicating better predictive ability.

IV. ANALYSIS OF NAVY FIRST-TERM ATTRITION

Although bootcamp attrition is an important indicator of military success, most research tends to focus on attrition throughout the first-term of service. A sailor's failure to complete his or her first term of enlistment is viewed as an unplanned personnel loss to the Navy. If the Navy sets enlisted term lengths in a manner consistent with the human capital investment model, current contract lengths equal the time required by the Navy to recoup its initial training and recruiting investments in sailors. Thus, first-term attrition represents economic losses to the Navy. Consequently, this thesis uses first-term completion as the indicator of a successful Navy recruit.

A. DATA

Data on the first-term careers of Navy enlistees were provided by the Defense Manpower Data Center (DMDC) in Monterey, CA. The data set used for this portion of the thesis was constructed from the DMDC Enlisted Master and Loss File and contains observations for enlisted cohorts from fiscal years 1989 through 1997. Cohorts for fiscal years after 1997 were not be used, because the focus of this chapter is on 48-month attrition.[31] Therefore, to effectively analyze first-term attrition, enough time needed to pass so that these sailors could fulfill their four-year obligations.

[31] Although 48-month attrition is the focus of this chapter, 12-, 24-, and 36-month attrition are also analyzed.

The source database contains 522,925 observations. However, to promote the homogeneity of the data set, recruits with an 8-year term of enlistment (primarily reservists) were not considered (n=97,988). Additionally, recruits entering the Navy as an E-4 or above were not considered and observations with missing or unreliable data were deleted; this results in a data set with 401,681 observations for analysis. Statistical Analysis System (SAS) software was used to process and analyze the data.

B. METHODOLOGY

The nine years of enlisted cohort data were used to analyze attrition patterns of various groups of educational credential holders. Unlike CNRC, DMDC did not provide an "attrition" variable, so one was constructed by analyzing the Total Active Federal Military Service (TAFMS) variable for each observation. Four dependent variables were constructed and analyzed: attrite12, attrite24, attrite36, and attrite48, representing 12-, 24-, 36-, and 48-month attrition, respectively. 45 months was used as the cut-off for the 48-month attrition variable, since it is common for "successful" sailors to be let out of their commitment up to three months early, for education, employment, and family considerations.

C. VARIABLES

1. Educational Credential Variables

The independent variables of primary interest for this analysis were the same educational credential variables described in Chapter III, with a few exceptions (see Table 2 for a description of these variables). Home school and

National Guard Youth Challenge Program graduates were not represented in sufficient numbers in the DMDC data set for meaningful statistical analysis, so these categories were omitted. These two types of alternative credentials have grown in popularity in recent years. However, since the DMDC data set contains observations that are 10 to 15 years older than those in the CNRC data set from Chapter III, it does not reflect the recent trends with regards to these two educational credentials. Additionally, prior to fiscal year 1998, home school graduates were not included in Tier I. Therefore, less enlistment opportunities were available for applicants in this growing educational category during the fiscal years contained in the DMDC data set (1989 through 1997).

A sufficient number of high school Certificate of Attendance recipients were found in the DMDC data, so a new educational credential variable (Cert2) was created. Certificate of Attendance holders were also present in the CNRC data set; but, because the CNRC data set contained fewer fiscal years (and, perhaps, because the Certificate of Attendance became a less popular alternative credential as other options became more readily available), recruits possessing this alternative credential were not present in the CNRC data set in sufficient numbers to ensure statistically significant analysis. Therefore, they were not addressed in Chapter III.

2. Control Variables

Most of the same control variables utilized in the logit models in Chapter III (described in Table 4) were used in the present analysis. However, some differences in variable definitions should be noted:

- Race variables were broken out differently; in addition to White, Black, and Hispanic, AIAN (American Indian/Alaskan Native) and API (Asian/Pacific Islander) were used instead of APINA and MultiRace;

- Marital status and dependents status were combined to create four dummy variables: SND (Single, No Dependents), SWD (Single, With Dependents), MND (Married, No Dependents), and MWD (Married, With Dependents);

- Recruits with 5-year and 6-year commitments were not represented in the data set in sufficient numbers for meaningful statistical analysis, so Term5 and Term6 control variables are not included;

- The data set allowed the inclusion of a dummy variable indicating whether or not a recruit had been granted an enlistment waiver (Waived);

- DEP duration was expressed in months instead of days; and

- Due to lack of availability, the school guarantee and bonus variables (NSG and Bonus, respectively) were omitted and a dummy variable measuring whether or not the recruit entered with any enlistment option (advanced enlistment grade, accelerated promotion, buddy program, desired unit or geographic location, training or skill guarantee, etc.) was added (NoOption).

Table 11 contains a detailed description of these variables. As in Chapter III, the “base case” was the “average” recruit—a Tier I, single, white, 19-year old male with no dependents, entering the Navy as an E-1 with no waiver and no enlistment option, with an AFQT of 62 and having been in the DEP for 5 months.

Table 11. Variable Descriptions and Descriptive Statistics

Variable	Description	Mean	Std Dev	Min	Max
Attrite12	= 1 if "Attrited" during first 12 months of service, 0 otherwise	.1772	.3819	0	1
Attrite24	= 1 if "Attrited" during first 24 months of service, 0 otherwise	.2648	.4412	0	1
Attrite36	= 1 if "Attrited" during first 36 months of service, 0 otherwise	.3383	.4731	0	1
Attrite48	= 1 if "Attrited" during first 45 months of service, 0 otherwise	.4184	.4933	0	1
Female	= 1 if Female, 0 otherwise	.1446	.3517	0	1
AIAN	= 1 if American Indian or Alaskan Native, 0 otherwise	.0094	.0965	0	1
API	= 1 if Asian/Pacific Islander, 0 otherwise	.0297	.1699	0	1
Black	= 1 if Black, 0 otherwise	.1712	.3767	0	1
Hispanic	= 1 if Hispanic, 0 otherwise	.0907	.2871	0	1
SWD	= 1 if Single with Dependents, 0 otherwise	.0351	.1839	0	1
MND	= 1 if Single with Dependents, 0 otherwise	.0243	.1540	0	1
MWD	= 1 if Single with Dependents, 0 otherwise	.0259	.1588	0	1
E2	= 1 if Entered as an E-2, 0 otherwise	.0815	.2736	0	1
E3	= 1 if Entered as an E-3, 0 otherwise	.1673	.3732	0	1
Column2	= 1 if Tier II or III, based on educational credential, 0 otherwise	.0526	.2232	0	1
Tier2	= 1 if Tier II, 0 otherwise	.0309	.1731	0	1
Tier3	= 1 if Tier III, 0 otherwise	.0216	.1455	0	1
Waived	= 1 if Enlisted with a Waiver, 0 otherwise	.2930	.4551	0	1
NoOption	= 1 if No Enlistment Option, 0 otherwise	.1199	.3248	0	1
Age	Age in Years (17-34)	19.68	2.541	17	34
AFQT	AFQT Percentile (31-99)	62.32	18.84	31	99
DEPMonths	Number of Months in DEP	5.008	3.662	0	12
DEPSq	Number of Months Squared	38.49	44.59	0	144

Source: Derived from data provided by Defense Manpower Data Center DMDC), 2003.

D. RESULTS

This section presents the results of the first-term attrition analysis. Results for 12-, 24-, and 36-month attrition are included, but 48-month attrition is the primary focus of this section.

1. First-Term Attrition Trends

Cross-tabulations from the DMDC data show that overall attrition rates have remained relatively constant over the nine-year period; an increase in 12-month attrition seems to have been offset by a decrease in 48-month attrition (See Figure 5).

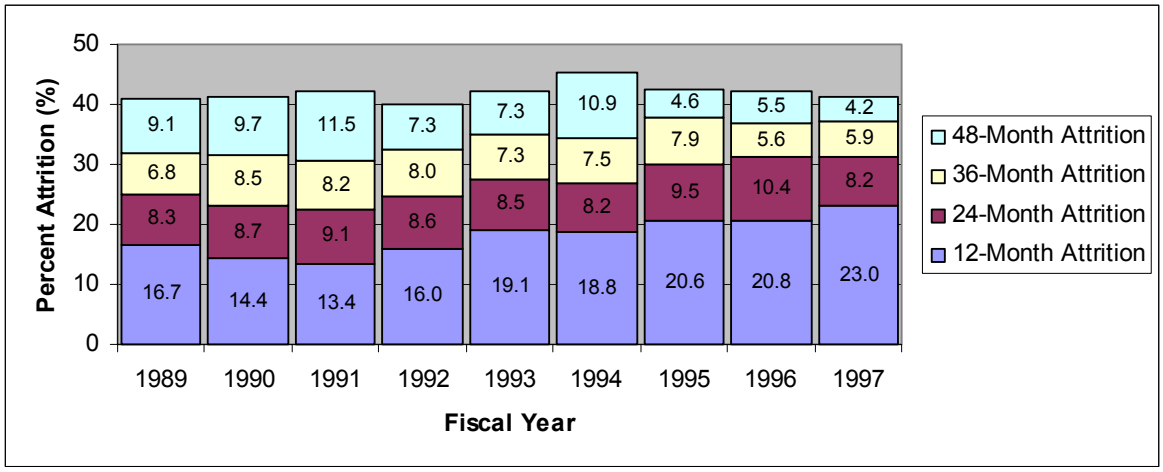

Figure 5. First-Term Attrition Rates (Percent) by 12-Month Periods, Fiscal Years 1989 through 1997
Source: Derived from data provided by Defense Manpower Data Center (DMDC), 2003.

2. Attrition by Educational Tier and Matrix Column

Cross-tabulations of first-term attrition by educational tier and matrix column provide results consistent with the bootcamp attrition patterns observed in Chapter III. Table 12 shows that, as with bootcamp attrition (which is a subset of first-term attrition), Tier

II recruits have attrition rates similar to those of Tier III recruits, and both groups experience attrition at higher rates than do Tier I recruits.

Table 12. First-Term Attrition Rates (Percent), by 12-Month Periods, Fiscal Years 1989 through 1997

Variable	N	12-Month	24-Month	36-Month	48-Month
Column I/*Tier I*	380,568	17.0	25.4	32.6	40.7
Column II	21,113	30.0	45.3	55.3	62.7
Tier II	*12,423*	*29.8*	*44.7*	*54.3*	*61.6*
Tier III	*8,690*	*30.4*	*46.0*	*56.8*	*64.3*
Total	**401,681**	**17.7**	**26.5**	**33.8**	**41.8**

Source: Derived from data provided by Defense Manpower Data Center (DMDC), 2003.

As in Chapter III, two models were constructed for each of the four dependent variables—a “column” model and a “tier” model. For the tier model, the Column2 variable was replaced with dummy variables representing Tier2 and Tier3. Also, for all of these models, the “base case” was a Tier I, single, white, 19-year old male with no dependents, entering the Navy as an E-1 with a four-year commitment and some form of enlistment option, without a waiver, with an AFQT of 62 and having been in the DEP for 5 months. The theoretical specification for each of the logit models utilized in this section is as follows:

Attrite12/24/36/48 = B0 + B1(Age) + B2(Female) + B3(Black) + B4(Hispanic) + B5(AIAN) + B6(API) + B7(SWD) + B8(MND) + B9(MWD) + B10(AFQTPerc) + B11(Waived) + B12(E2) + B13(E3) + B14(Column2) + B15(MonDEP) + B16(DEPSq) + B17(NoOption) + μ.

All of the models were validated to ensure suitability. In each case, the AFQT and educational

variables retained their significance when the additional independent variables were added, and the maximum rescaled R-squared values increased from 0.0154 to 0.0400 (12-month attrition), 0.0218 to 0.0507 (24-month attrition), 0.0253 to 0.0561 (36-month attrition), and 0.0248 to 0.0554 (48-month attrition). Regression results from both 48-month attrition models are presented in Tables 13 and 14. Appendix A contains the logit regression results for the 12-, 24-, and 36-month attrition models.

Table 13. Logit Regression Results using Matrix Columns: 48-Month Attrition

Variable	Estimate	Std Error	P-Value
Intercept	0.5431	0.0327	<.0001
Age*	1.44E-3	1.44E-3	0.3174
Female	0.2152	9.28E-3	<.0001
Black	-0.2339	9.29E-3	<.0001
Hispanic	-0.3014	0.0118	<.0001
AIAN	0.1080	0.0334	0.0012
API	-0.8878	0.0220	<.0001
SWD	0.2401	0.0180	<.0001
MND	0.0443	0.0215	0.0393
MWD	-0.0888	0.0212	<.0001
AFQTPerc	-9.48E-3	1.99E-4	<.0001
Waived	0.2359	7.37E-3	<.0001
E2	-0.1637	0.0122	<.0001
E3	-0.3010	0.0101	<.0001
MonDEP	-0.0997	3.65E-3	<.0001
DEPSq	4.50E-3	2.99E-4	<.0001
NoOption	0.1081	0.0102	<.0001
Column2	**0.7369**	**0.0151**	**<.0001**
Max Rescaled R-Square	0.0554		
Likelihood Ratio	16,881.5		
Pr>ChiSq	<0.0001		
N	401,681		

Source: Derived from data provided by Defense Manpower Data Center DMDC), 2003.
* Not statistically significant.

Table 14. Logit Regression Results using Educational Tiers: 48-Month Attrition

Variable	Estimate	Std Error	P-Value
Intercept	0.5361	0.0328	<.0001
Age*	1.76E-3	1.44E-3	0.2227
Female	0.2154	9.28E-3	<.0001
Black	-0.2337	9.29E-3	<.0001
Hispanic	-0.3015	0.0118	<.0001
AIAN	0.1083	0.0334	0.0012
API	-0.8883	0.0220	<.0001
SWD	0.2403	0.0180	<.0001
MND	0.0445	0.0215	0.0381
MWD	-0.0883	0.0212	<.0001
AFQTPerc	-9.48E-3	1.99E-4	<.0001
Waived	0.2360	7.37E-3	<.0001
E2	-0.1639	0.0122	<.0001
E3	-0.3014	0.0101	<.0001
MonDEP	-0.0995	3.65E-3	<.0001
DEPSq	4.49E-3	2.99E-4	<.0001
NoOption	0.1078	0.0102	<.0001
Tier2	**0.6923**	**0.0192**	**<.0001**
Tier3	**0.8021**	**0.0232**	**<.0001**
Max Rescaled R-Square	0.0554		
Likelihood Ratio	16,895.8		
Pr>ChiSq	<0.0001		
N	401,681		

Source: Derived from data provided by Defense Manpower Data Center DMDC), 2003.
* Not statistically significant.

Results for the control variables are similar to the results obtained in the bootcamp attrition model (using the CNRC data set). However, one ethnic variable (American Indian/Alaskan Native) is associated with increased attrition. Interestingly, age at enlistment becomes less significant as time until attrition increases (from 12 to 48 months), while being female (positive effect) becomes larger. Regarding the new control variables (those not included in the CNRC data set), both Waived and NoOption

are statistically significant and associated with increased attrition, all other factors held constant. In other words, enlisting with a waiver (i.e. having a medical, moral, or legal situation that would normally preclude enlistment) results in an increased likelihood of first-term attrition; and, joining the Navy without an enlistment option (such as a training or accelerated promotion guarantee) also increases the probability of first-term attrition.

As with the CNRC data analysis in the previous chapter, the estimates of the primary independent variables (AFQT score and educational status) are significant and as predicted. All become larger as time until attrition increases (from 12 to 48 months). This was expected. Since the attrition variables are cumulative, later attrition variables (attrite24, attrite36, and attrite48) include all of the attrition from the earlier variables, plus whatever attrition occurred within the most recent 12 months. Table 15 shows the partial effects for each of these variables; as expected, partial effects increase from left to right.

Table 15. Partial Effects of AFQT and Educational Variables, by 12-Month Period[a]

Variable	**12-Month**	**24-Month**	**36-Month**	**48-Month**
AFQT[b]	-0.0012	-0.0016	-0.0019	-0.0023
Column 2[c]	0.0919	0.1508	0.1829	0.1821
Tier 2[d]	*0.0867*	*0.1438*	*0.1714*	*0.1712*
Tier 3[d]	*0.0995*	*0.1608*	*0.1995*	*0.1979*

Source: Derived from Results in Tables 13, 14, and 23-28.
[a] All results are significant.
[b] Same for both models.
[c] From model with matrix columns as dependent variables.
[d] From model with educational tiers as dependent variables.

3. Attrition by Educational Credential

As observed in Chapter III, cross-tabulations show that the various educational subgroups within the educational tiers and matrix columns are associated with different attrition rates. Table 16 contains tabulations of first-term attrition rates by the individual educational categories contained in the DMDC data set.

Table 16. First-Term Attrition Rates (Percent), by 12-Month Period and Educational Credential

Credential (Tier)	N	12-Month	24-Month	36-Month	48-Month
Dropout (III)	8,690	30.4	46.0	56.8	64.3
GED (II)	11,265	30.2	45.2	54.7	61.8
Certificate(II)	1,158	25.8	40.2	50.9	59.2
One Coll Sem(I)	7,347	27.1	39.9	49.1	56.2
Adult School(I)	10,322	26.8	39.9	49.1	56.3
HS Grad (I)	355,336	16.6	24.8	32.0	40.1
Assoc Degree(I)	2,833	15.5	21.6	27.8	33.9
Bach Degree (I)	4,730	13.0	18.9	23.6	30.7
Total	**401,681**	**17.7**	**26.4**	**33.9**	**41.8**

Source: Derived from data provided by Defense Manpower Data Center (DMDC), 2003.

As a whole, Tier I recruits have lower attrition rates than those in Tiers II and III. However, there is considerable variation within Tier I depending on type of educational credential. As seen in Table 16, non-traditional high school graduates with at least one college semester and adult-school graduates tend to have very similar attrition rates, and they are more comparable to Tier II and Tier III attrition rates than to those of traditional high school graduates and those with a college degree.

Logit models were used to analyze the data after grouping recruits by their educational credentials. The same statistical models were used as before, except that the eight individual educational categories were used instead of the tier and column variables. The same control variables from the “tier” and “column” models were used in the disaggregated model.

These models were also validated to ensure suitability. Again, the AFQT and educational variables retained their significance when the additional independent variables were added; the maximum rescaled R-squared values increased from 0.0194 to 0.0424 (12-month attrition), 0.0277 to 0.0547 (24-month attrition), 0.0317 to 0.0607 (36-month attrition), and 0.0300 to 0.0591 (48-month attrition).

Results from the 48-month logit attrition model are presented in Table 17. (Appendix B contains the regression results for the 12-, 24-, and 36-month attrition models.) All of the Tier II and III variables, as well as the non-traditional Tier I variables, had positive coefficients, indicating higher attrition rates than the base case (traditional high school graduates), holding other variables constant. Post-secondary Tier I variables (Assoc1 and Bach1) had negative coefficients, indicating lower attrition rates.

Table 17. Logit Regression Results for Educational Variables: 48-Month Attrition[a]

Variable	Estimate	Std Error	P-Value
Intercept	0.5283	0.0337	<.0001
Age[b]	-1.50E-3	1.50E-3	0.9204
Female	0.2222	9.30E-3	<.0001
Black	-0.2270	9.31E-3	<.0001
Hispanic	-0.3138	0.0118	<.0001
AIAN	0.0986	0.0335	0.0033
API	-0.8936	0.0220	<.0001
SWD	0.2220	0.0181	<.0001
MND	0.0353	0.0215	0.1015
MWD	-0.1056	0.0213	<.0001
AFQTPerc	-9.15E-3	2.00E-4	<.0001
Waived	0.2264	7.38E-3	<.0001
E2	-0.1871	0.0123	<.0001
E3	-0.2791	0.0104	<.0001
MonDEP	-0.1005	3.65E-3	<.0001
DEPSq	4.70E-3	2.99E-4	<.0001
NoOption	0.1077	0.0102	<.0001
Dropout3	**0.8302**	**0.0232**	**<.0001**
Cert2	**0.8167**	**0.0606**	**<.0001**
GED2	**0.7139**	**0.0202**	**<.0001**
Adult1	**0.4967**	**0.0205**	**<.0001**
CollSem1	**0.5725**	**0.0245**	**<.0001**
Assoc1	**-0.0689**	**0.0414**	**0.0964**
Bach1	**-0.1220**	**0.0338**	**0.0003**
Max Rescaled R-Square	0.0591		
Likelihood Ratio	18,031.9		
Pr>ChiSq	<0.0001		
N	401,681		

Source: Derived from data provided by Defense Manpower Data Center DMDC), 2003.
[a] Traditional high school graduates comprise the base group.
[b] Not statistically significant.

The partial effects of educational credentials are shown in Table 18; they were derived from the logit coefficients presented in Table 17 and Appendix B.

Table 18. Partial Effects of Educational Credentials by 12-Month Attrition Periods

Credential (Tier)	12-Month	24-Month	36-Month	48-Month
Dropout (III)	0.1036	0.1670	0.2067	0.2046
GED (II)	0.0976	0.1607	0.1978	0.2014
Certificate (II)	0.0907	0.1500	0.1776	0.1764
One Coll Sem (I)	0.0759	0.1200	0.1454	0.1414
Adult School (I)	0.0650	0.1076	0.1286	0.1226
Assoc Degree* (I)	-0.0005	-0.0111	-0.0120	-0.0163
Bach Degree (I)	-0.0212	-0.0293	-0.0413	-0.0288

Source: Derived from Results in Tables 17 and 29-31.
*Not statistically significant

These partial effects, multiplied by 100, represent the percentage-point variation from the base case (traditional high school graduates). For example, the 48-month attrition rate for a high school dropout in this data set was approximately 20 percentage-points higher than that of a traditional high school graduate, while the 48-month attrition rate for a Bachelor’s Degree-holder was about 3 percentage-points lower than that of a traditional high school graduate with no post-secondary education, all other factors being held constant.

4. Summary of Results from DMDC Data Analysis

As in Chapter III, the significant variation in attrition rates between various categories of educational credential holders suggests that the aggregated columns and tiers may not predict first-term attrition as effectively as the individual groupings of educational credentials. This is supported by the fact that the maximum rescaled R-squared values for the four aggregated models (attrite12, attite24, attrite36, and attrite48) were 0.0400, 0.0507, 0.0561, and 0.0554, respectively. When the groupings of educational credentials were examined separately, the

maximum rescaled R-squared values increased to 0.0424, 0.0547, 0.0607, and 0.0591, indicating better overall predictive ability.

THIS PAGE INTENTIONALLY LEFT BLANK

V. RECRUIT QUALITY MATRIX VALIDATION

To validate educational credentials as predictors of first-term completion, so that a refined screening tool can be developed, a new model was constructed so that only the variables used to predict attrition in the Recruit Quality Matrix (AFQT score and individual educational credentials) are included. The theoretical specification is as follows:

Attrite48 = B0 + B1(AFQTPerc) + B2(Dropout3) + B3(Cert2) + B4(GED2) + B5(Adult1) + B6(CollSem1) + B7(Assoc1) + B8(Bach1) + μ.[32]

In this restricted model, other important factors (such as gender, race, and age) are omitted. Inclusion of other control variables would tend to reduce the partial effects of AFQT and the educational credentials. If other control variables were used in a screening tool (such as a composite predictor of first-term attrition), they would be included in a regression model to get the most accurate partial effects for all independent variables. But, with a screening tool like the Recruit Quality Matrix, where only two variables are considered, the other control variables should not be included in the regression. In this way, when the omitted variables are correlated with the 'focus' variables (AFQT and educational credentials), the omitted variables' effects are "picked up" by the focus variables. So, even though other control variables are used to explain attrition in previous chapters, they are not used here to predict attrition.

[32] The "base case" was a traditional high school graduate. See Table 11 and Table 16 for variable descriptions.

Employing the method used by Rothstein to validate SAT (formerly Scholastic Aptitude Test) scores and high school grade point average (GPA) as predictors of college freshman GPA, two additional models were constructed to validate AFQT and individual educational credentials as predictors of first-term attrition. The first model contains only AFQT score as an independent variable, and the second includes only educational credential variables.[33]

Using the same DMDC data from Chapter IV, Ordinary Least Squares (OLS) regression was conducted on all three models, so that the value "R" (the square root of R-squared) derived from minimizing the sum of squared residuals could be used in the same manner employed by Rothstein to validate the SAT.[34] The OLS estimation results are presented in Tables 19, 20, and 21, respectively.

[33] Jesse M. Rothstein, College Performance Predictions and the SAT (Berkely, CA: UC Berkeley Center for Labor Economics, 2003), 4-5.

[34] These models are used by educational researchers to validate test scores and other screening variables (see citations in Rothstein).

Table 19. OLS Regression Results for AFQT and Educational Variables: 48-Month Attrition

Variable	Estimate	Std Error	P-Value
Intercept	0.5434	2.69E-3	<.0001
AFQT	-2.30E-3	4.12E-5	<.0001
Dropout3	0.2491	5.30E-3	<.0001
Cert2	0.1969	0.0144	<.0001
GED2	0.2259	4.67E-3	<.0001
Adult1	0.1465	4.88E-3	<.0001
CollSem1	0.1506	5.75E-3	<.0001
Assoc1	-0.0391	9.21E-3	<.0001
Bach1	-0.0500	7.18E-3	<.0001
R-Square	0.0226		
R	0.1503		
N	401,681		

Source: Derived from data provided by Defense Manpower Data Center (DMDC), 2003.
* All results are statistically significant.

Table 20. OLS Regression Results for AFQT Only: 48-Month Attrition

Variable	Estimate	Std Error	P-Value
Intercept	0.5637	2.68E-3	<.0001
AFQT	-2.33E-3	4.11E-5	<.0001
R-Square	0.0079		
R	0.0889		
N	401,681		

Source: Derived from data provided by Defense Manpower Data Center (DMDC), 2003.
* All results are statistically significant.

Table 21. OLS Regression Results for Educational Variables Only: 48-Month Attrition

Variable	Estimate	Std Error	P-Value
Intercept	0.4009	8.21E-4	<.0001
Dropout3	0.2418	5.32E-3	<.0001
Cert2	0.1915	0.0144	<.0001
GED2	0.2175	4.69E-3	<.0001
Adult1	0.1618	4.89E-3	<.0001
CollSem1	0.1608	5.77E-3	<.0001
Assoc1	-0.0617	9.23E-3	<.0001
Bach1	-0.0935	7.17E-3	<.0001
R-Square	0.0151		
R	0.1229		
N	401,681		

Source: Derived from data provided by Defense Manpower Data Center (DMDC), 2003.
* All results are statistically significant.

Because OLS regressions were estimated, the regression coefficients are directly interpretable. Thus, the coefficient of 0.2259 for GED2 (from Table 19) indicates that a GED recipient has an attrition probability that is 22.59 percentage points higher than that of the base case—a traditional high school graduate—all other factors being held constant. However, the primary reason for conducting OLS regression is to calculate R values in order to validate the educational credentials as predictors of first-term completion. Therefore, R-squared values are converted to R values:

- R(AFQT and educational credentials) = square root (0.0226) = 0.1503;
- R(AFQT only) = square root (0.0079) = 0.0889 (raw validity of AFQT); and
- R(educational credentials only) = square root (0.0151) = 0.1229 (raw validity of educational credentials).

The incremental validity of educational credentials as predictors of first-term attrition is 0.1503 – 0.0889 = 0.0614.[35]

As mentioned previously, OLS regression is useful for validating the predictive ability of educational credentials, and its coefficients are directly interpretable. However, OLS regression has limited applicability in constructing a predictive tool, because the dependent variable in this case (attrite48) is a dummy variable bounded by 0 and 1; however, the OLS model is linear and unbounded. Therefore, a logit model was used to predict attrition probabilities and to construct the refined Recruit Quality Matrix. The same model specification from earlier in this chapter was employed (with just AFQT and educational credentials as independent variables), and the logit model output is presented in Table 22. The resulting parameter estimates are:

Log-odds(attrite48) = 0.1928 – 0.00963(AFQT) + 1.0247(Dropout3) + 0.8034(Cert2) + 0.9246(GED2) + 0.5945(Adult1) + 0.6123(CollSem1) – 0.1717(Assoc1) – 0.2289(Bach1).[36]

"Log-odds" were calculated for "Attrite48", for different AFQT scores when each separate educational dummy variable was set equal to one (and all other educational dummy variables were set equal to zero). These values were then converted to probabilities of attrition (probability of attrition = 1/[1+EXP(Log-Odds[Attrite48])]), which were in turn converted to probabilities of completion

[35] These incremental validity measures can be compared to those for SAT scores in Rothstein, 27-30.

[36] The base case is a traditional high school graduate.

(probability of completion = 1 – probability of attrition). See Appendix C for tables containing the log-odds values, predicted attrition probabilities, and predicted completion probabilities, by AFQT score and educational credential.

Table 22. Logit Regression Results for AFQT and Educational Variables: 48-Month Attrition

Variable	Estimate	Std Error	P-Value
Intercept	0.1928	0.0112	<.0001
AFQT	-9.63E-3	1.74E-4	<.0001
Dropout3	1.0247	0.0227	<.0001
Cert2	0.8034	0.0600	<.0001
GED2	0.9246	0.0197	<.0001
Adult1	0.5945	0.0202	<.0001
CollSem1	0.6123	0.0239	<.0001
Assoc1	-0.1717	0.0400	<.0001
Bach1	-0.2289	0.0320	<.0001
Max Rescaled R-Square	0.0300		
Likelihood Ratio	9,058.8		
Pr>ChiSq	<0.0001		
N	401,681		

Source: Derived from data provided by Defense Manpower Data Center (DMDC), 2003.
* All results are statistically significant.

These probabilities of completion were used to construct a more refined Recruit Quality Matrix, with individual educational credentials arranged left to right across the top of the matrix, from most successful to least successful. The refined matrix was set up so that completion rates could be discerned by cross-referencing AFQT scores and educational credentials, much like in the current matrix. Three benchmark completion rates were chosen—60 percent, 50 percent, and 40 percent—because they loosely correlate to the completion rates associated with the minimum AFQT scores in the current A-cell, Cu-Cell, and

B-Cell, respectively. Figure 6 is a graphic representation of this refined Recruit Quality Matrix, derived from the predicted probabilities of completion in Appendix C.

By using more categories of educational credentials, the refined matrix more accurately predicts completion probabilities. With the current matrix, for any given AFQT score, the same completion probability is predicted for recruits with Bachelor's Degrees, Associate's Degrees, traditional high school diplomas, adult education diplomas, and one college semester, because they are all grouped in the first column. However, with the refined matrix, these five distinct populations result in five different predicted completion rates.

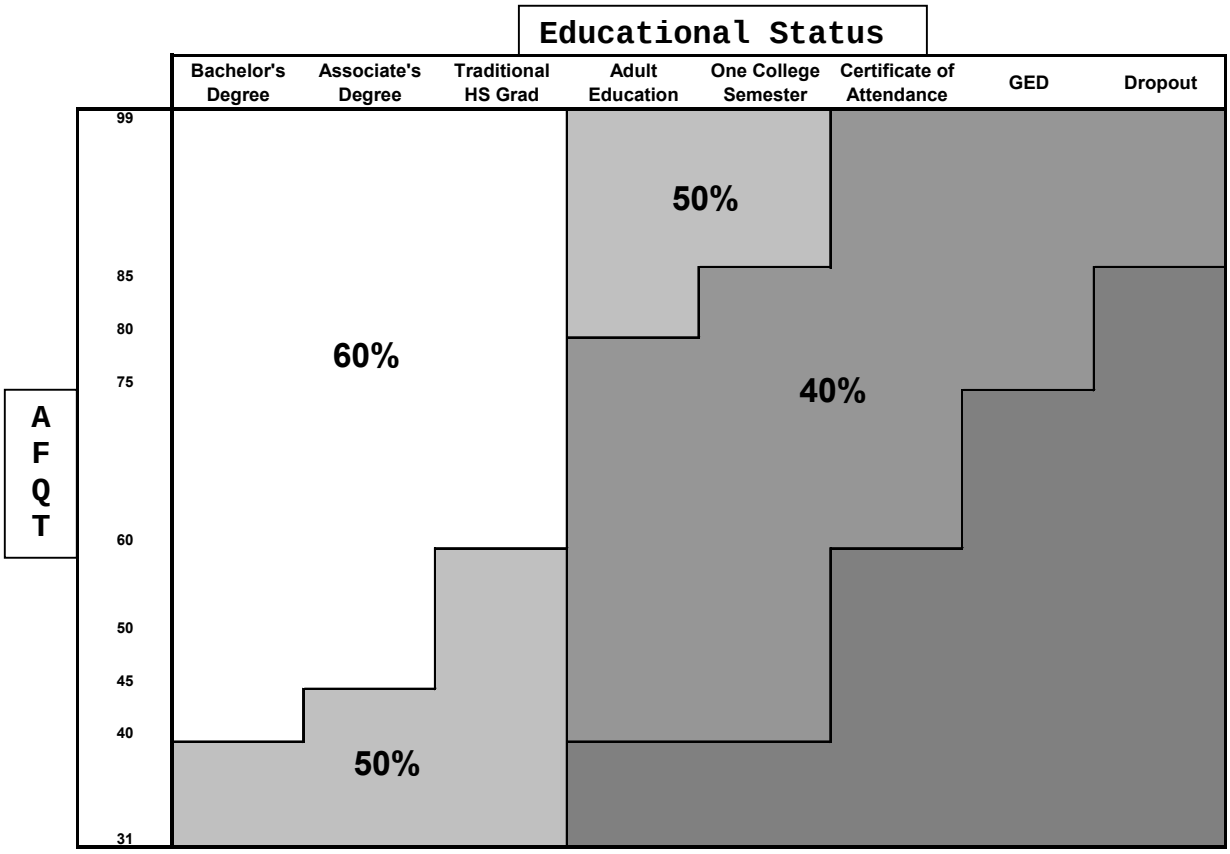

Figure 6. Predicted Probability of First-Term Completion by AFQT Score and Educational Status

THIS PAGE INTENTIONALLY LEFT BLANK

VI. POTENTIAL RECRUIT QUALITY MATRIX REFINEMENTS

The expanded use of educational categories provided by the refined matrix, and the improved ability to predict first-term attrition, leads to several specific benefits in screening applicants for enlistment. These benefits are discussed in this chapter.

A. MEDIUM-APTITUDE COLLEGE DEGREE-HOLDERS (AREA 1)

The cross-hatched area in Figure 7 (Area 1) represents medium-aptitude college degree-holders (Associate's and Bachelor's degrees) who are currently grouped in Cu-Cell because they have AFQT scores below the 50th percentile. However, this subset of Cu-Cell recruits actually has a first-term completion rate of 60 percent or more, which is similar to that of A-Cell recruits. This is a small group of recruits; the data set contained 183 Bachelor's degree-holders with AFQT scores between the 40th and 50th percentile, and 125 Associate's degree-holders with AFQT scores between the 45th and 50th percentile. Nonetheless, because the size of the population that falls in this category is large, its inclusion in A-Cell would expand the pool of "high-quality recruits," which is the primary focus of the Navy's recruiting effort.

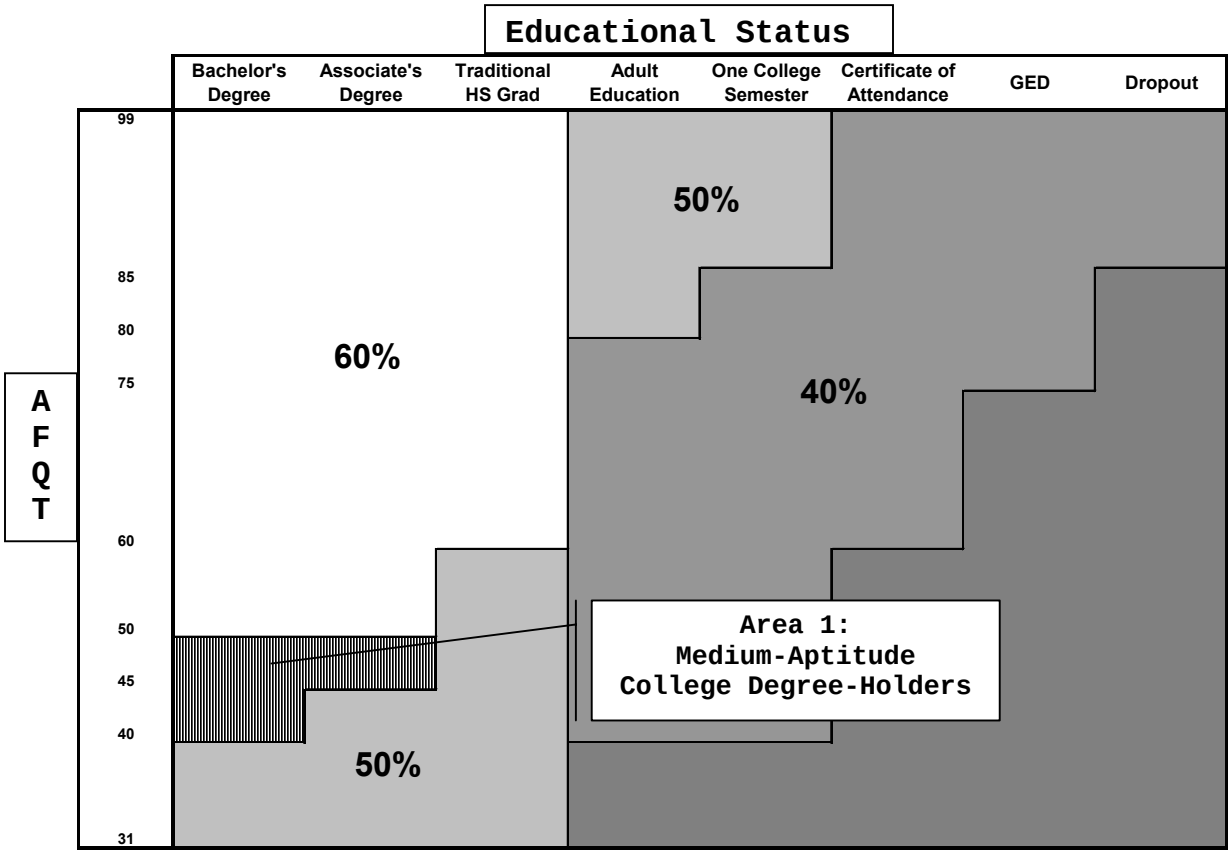

Figure 7. Predicted Probability of First-Term Completion: Medium-Aptitude College Degree-Holders

B. MEDIUM-APTITUDE TRADITIONAL HIGH SCHOOL GRADUATES (AREA 2)

In Figure 8, Area 2 represents A-Cell recruits who are aggressively targeted for enlistment because the have AFQT scores above the 50th percentile. However, this subset of A-Cell recruits (traditional high school graduates with AFQT scores between the 50th and 60th percentiles) actually has a first-term completion rate of less than 60 percent. Unlike the small group of medium-aptitude college-degree holders in Figure 6, medium-aptitude traditional high school graduates accounted for 63,302 of the approximately 400,000 recruits in the DMDC data set.

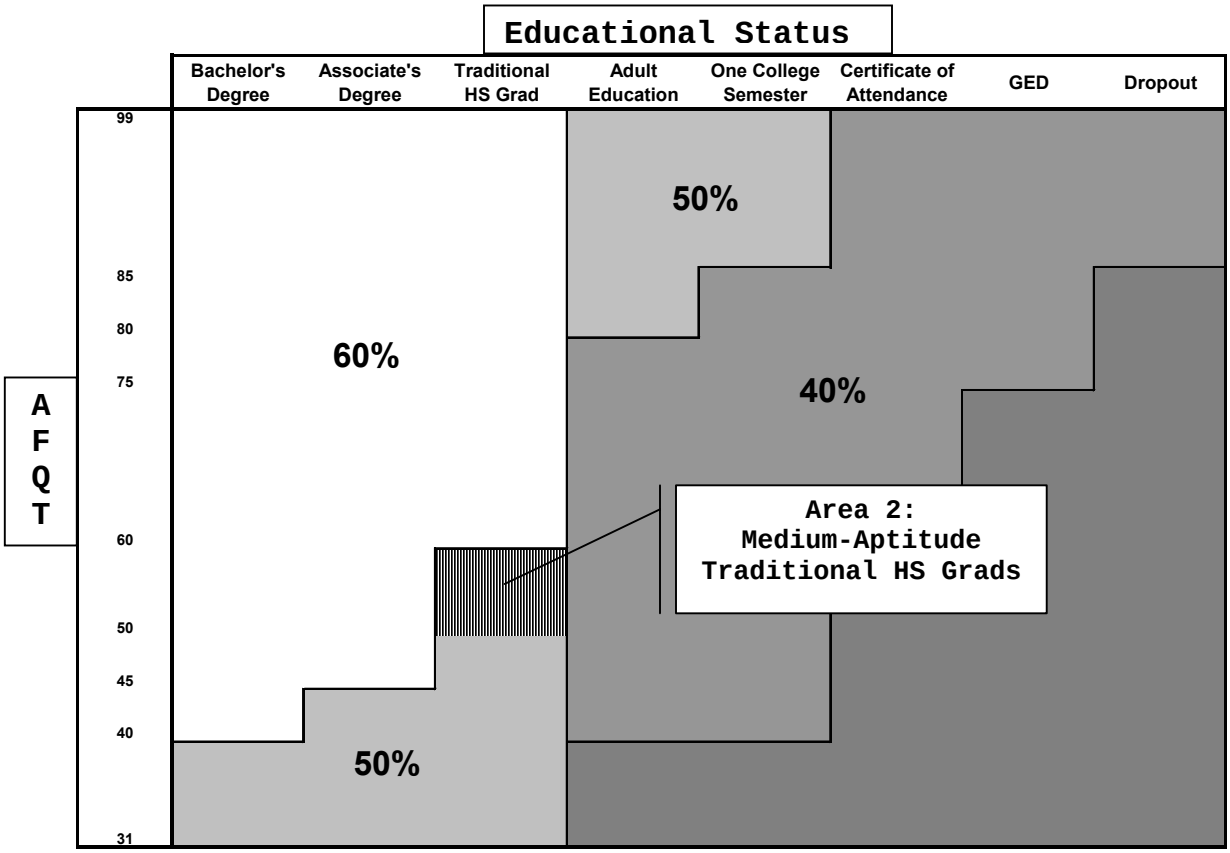

Figure 8. Predicted Probability of First-Term Completion: Medium Aptitude Traditional High School Graduates

Since they are so expensive to recruit ($15,530 per recruit), perhaps the A-Cell focus should shift toward traditional high school graduates with AFQT scores above the 60th percentile; the medium-aptitude A-Cell subgroup (AFQT scores between the 50th and 60th percentiles) does not provide the lower attrition rate the Navy counts on to offset higher recruiting outlays. After all, if the Navy is willing to accept attrition rates above 40 percent, Cu-Cell and higher-aptitude B-Cell applicants could be easily substituted and at a fraction of the recruiting cost. Currently, “high-quality recruits” account for about two-thirds of all enlistments. Because Area 2 is such a large

sub-group (in this data set and in the population), this goal would have to be adjusted downwards, to account for excluding medium-aptitude traditional high school graduates from the A-Cell.

C. TIER I ALTERNATIVE CREDENTIAL-HOLDERS (AREA 3)

Area 3 in Figure 9 represents A-Cell and Cu-Cell, Tier I alternative credential-holders who are targeted for enlistment because they have AFQT scores above the 31st percentile. However, this Tier I subset actually has an average first-term completion rate below 50 percent.

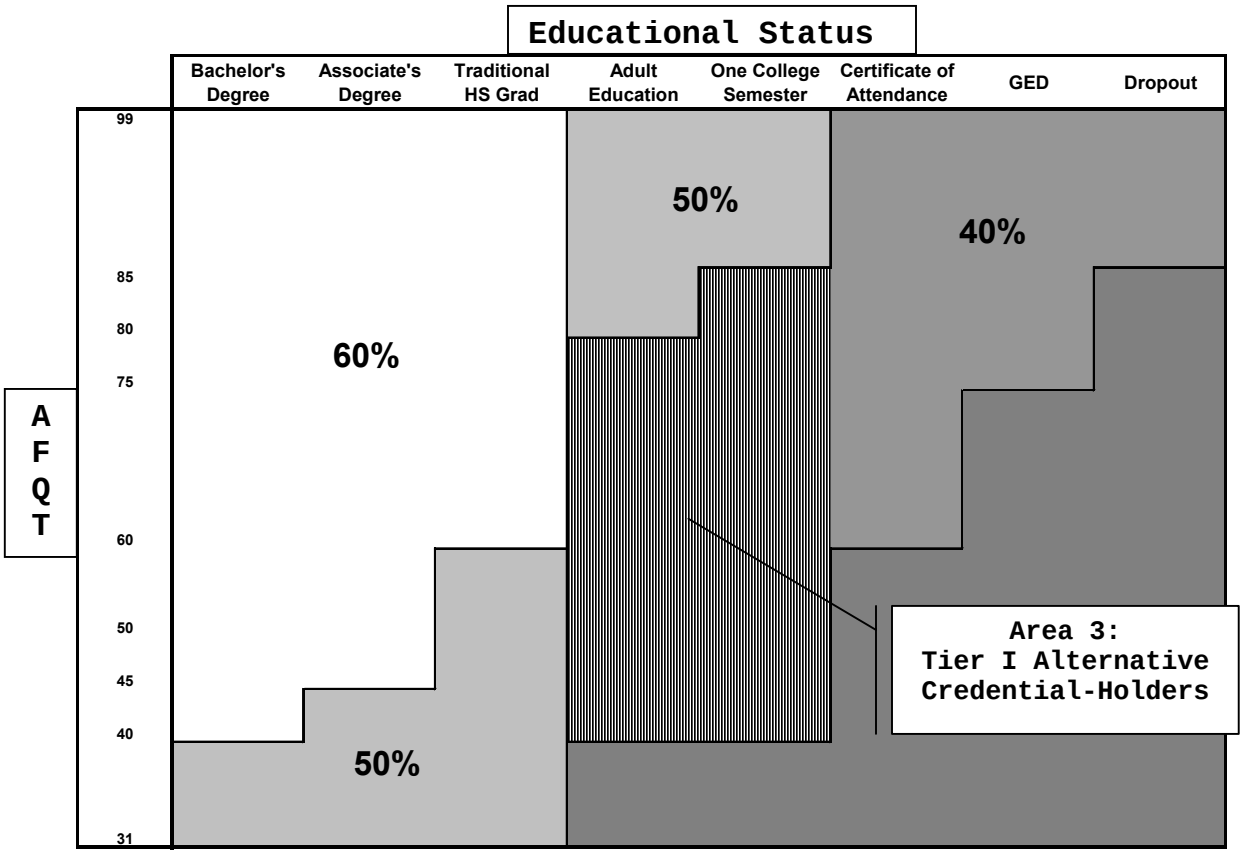

Figure 9. Predicted Probability of First-Term Completion: Tier I Alternative Credential-Holders

As discussed in Chapter IV, these Tier I alternative credential-holders have first-term attrition rates closer to those of Tier II recruits than to those of the other, more traditional Tier I recruits. These lower-aptitude adult-education graduates and non-traditional high school graduates with one semester of college represent 6,821 and 5,097, respectively, of the approximately 400,000 personnel in the data set. Because of their low completion probabilities, adult education graduates with AFQT scores between the 40th and 80th percentiles, and non-traditional high school graduates with one semester of college and AFQT scores between the 40th and 85th percentiles, should be given lower priority than other, higher-performing A-Cell and Cu-Cell applicants.

D. MEDIUM-APTITUDE B-CELL RECRUITS AND LOW-APTITUDE CU-CELL RECRUITS (AREA 4)

Area 4 in Figure 10 represents B-Cell recruits who are allowed to enlist because they have AFQT scores above the 50th percentile, and Cu-Cell recruits who are allowed to enlist because they have AFQT scores above the 31st percentile. But, these subgroups actually experience average first-term attrition rates of 60 percent or higher. Currently, within the B-Cell, Certificate of Attendance holders with AFQT scores between the 50th and 60th percentiles, GED recipients with AFQT scored between the 50th and 75th percentiles, and high school dropouts with AFQT scores between the 50th and 85th percentiles account for 393, 8,271, and 7,951, respectively, of the approximately 400,000 recruits in the DMDC data set. Within the Cu-Cell, adult-education graduates and non-traditional high school graduates with one semester of college, with AFQT scores

between the 31st and 40th percentiles, number 2,250 and 1,484 in the data set. But, based on the present research, these subgroups do not attain an acceptable first-term completion rate. Perhaps they should not be eligible for enlistment, and a higher minimum AFQT score for individuals in any of these five educational categories should be required to ensure a minimally acceptable standard of success (completion rate of at least 40 percent).

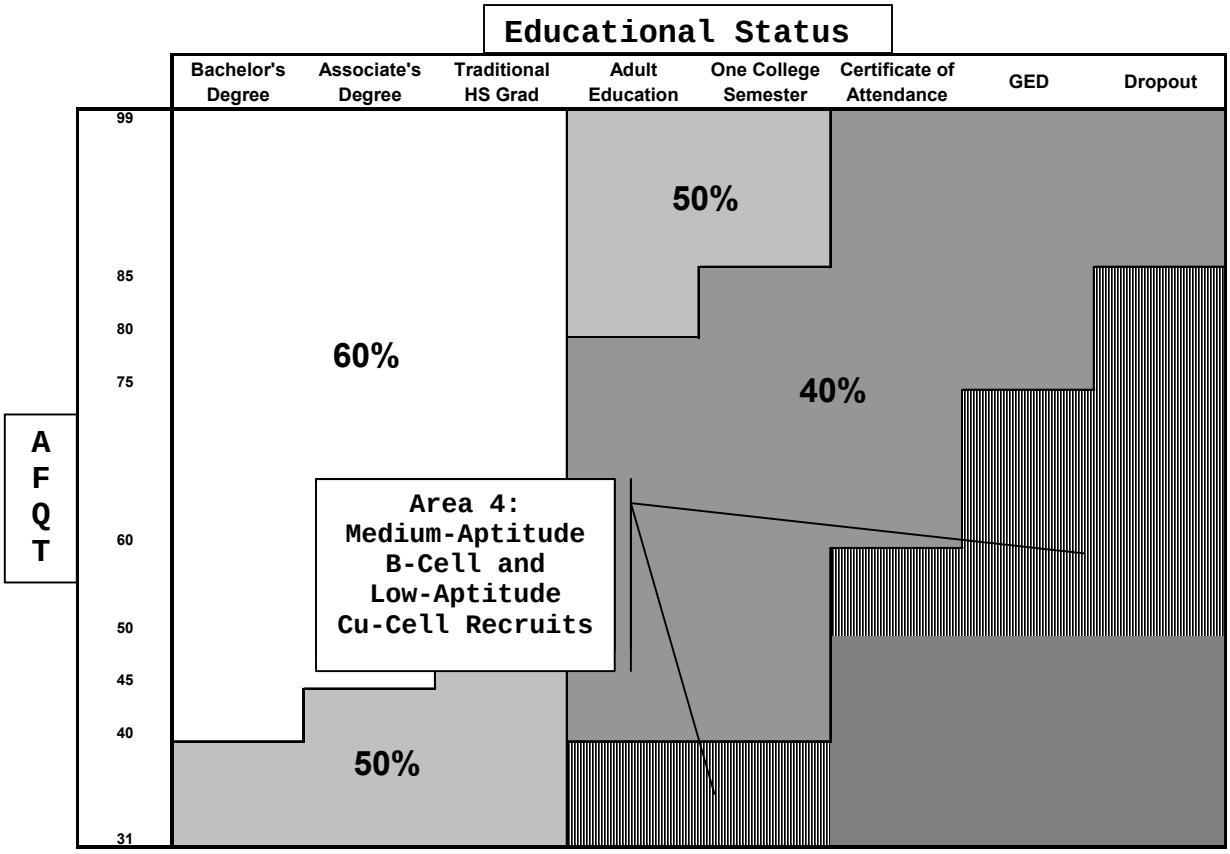

Figure 10. Predicted Probability of First-Term Completion: Medium-Aptitude B-Cell and Low-Aptitude Cu-Cell Recruits

E. LOW-APTITUDE TRADITIONAL HIGH SCHOOL GRADUATES

Another population of interest in the refined Recruit Quality Matrix is represented by Area 5 in Figure 11. This group is comprised of traditional high school graduates

(with and without a college degree) with an AFQT score below the 31st percentile. Currently, this group is not eligible for enlistment. However, based on the present study, it is estimated that they would have a first-term attrition rate on par with Cu-Cell and B-Cell applicants currently qualified for enlistment.

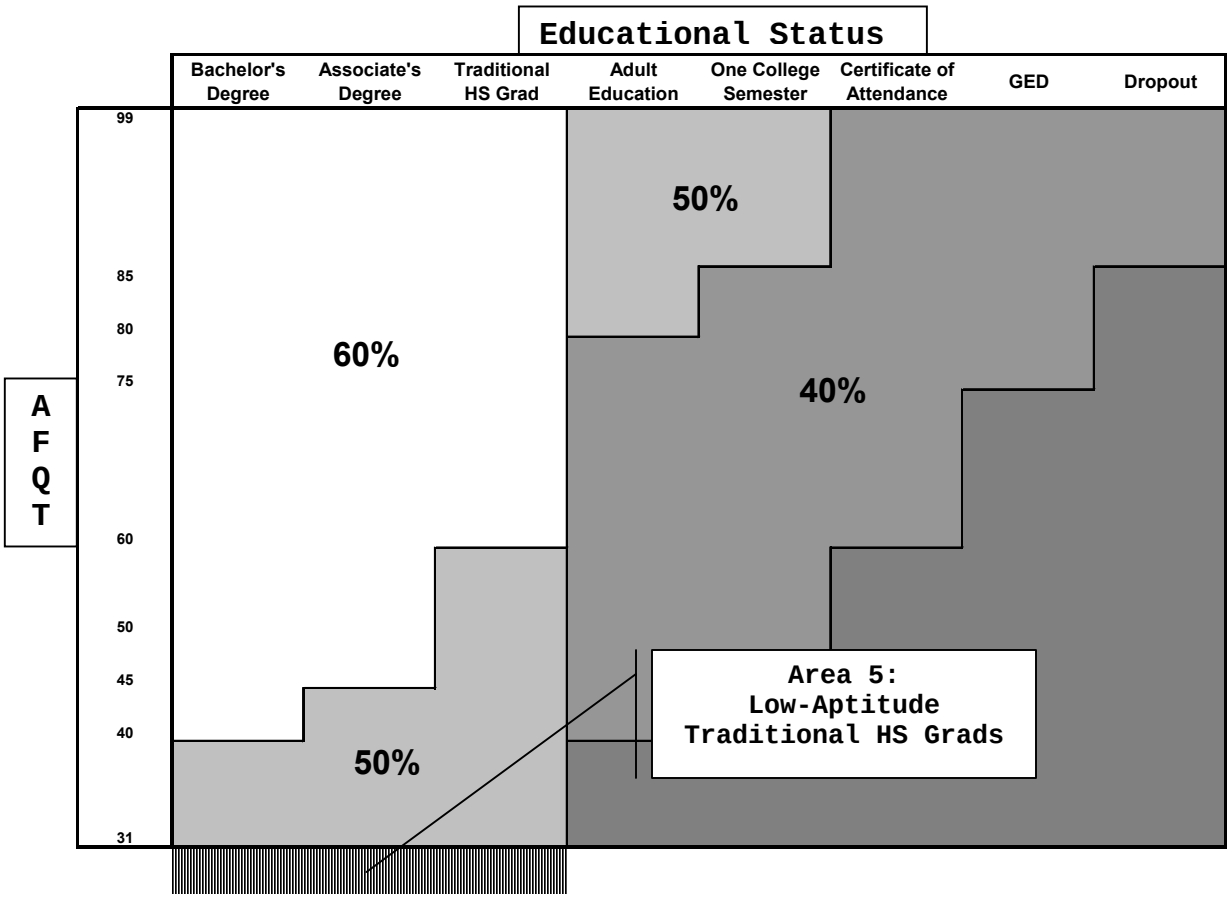

Figure 11. Predicted Probability of First-Term Completion: Low-Aptitude Traditional High School Graduates

Since no one in the DMDC data set has an AFQT score this low, they are outside of the relevant range of this analysis. Therefore, a definitive AFQT cut-off for this group (for a 50-percent completion rate, for instance) cannot realistically be established. Nevertheless, based

on the observed education differential effect of the AFQT variable (see Chapters III and IV), one can assume that some low-aptitude traditional high school graduates would achieve acceptable levels of first-term success. In today's recruiting environment, that may not be an acceptable risk. But, when the market is tight and making the recruiting goal for the year is in jeopardy, as it was in fiscal year 1998, opening up a large potential reserve of applicants with acceptable first-term completion rates might be desirable.[37]

[37] In fiscal year 1998, the Navy fell short of its annual recruiting goal by almost 7,000 recruits.

VII. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

A. SUMMARY

Because the educational categories in the Navy's current Recruit Quality Matrix are highly aggregated, it may not be the most accurate and effective method for predicting the potential success of applicants for enlistment. Specifically, adopting some of the refinements outlined in Chapter VI would help to reduce first-term attrition, and the costs associated with it, by deemphasizing the enlistment of applicants in Areas 2 and 3, and by avoiding altogether the enlistment of applicants in Area 4. Additionally, Area 1 offers a potentially useful source of "high-quality recruits." Further, Area 5 identifies a large potential pool of applicants who could be used as a reserve, for example when more traditional recruits are hard to attract and the Navy is in jeopardy of missing its recruiting goal.

Although it is clear that refinements can be made to increase the predictive ability of the recruit screening process, the predicted completion probabilities outlined in Chapters V and VI are only as good as the data from which they were derived. Because the Navy only enlists higher-performing Tier II and III recruits, it is possible that they are not completely representative of the Tier II and III population as a whole, and that selection bias is present. So, increased recruitment of targeted subgroups within Tiers II and III may result in lower completion rates than anticipated. However, this does not change the conclusion that a lower level of aggregation can increase the predictive ability of the recruit screening process.

B. CONCLUSIONS

This research does not suggest that Tier I recruits can be totally replaced by Tier II and III applicants, or even that a high AFQT score is a replacement for educational attainment. Nevertheless, the "education differential" introduced in 1950, and supported by this research, suggests that the Navy could get acceptable completion rates from Tier II and III recruits by controlling for AFQT scores. The growing supply of Tier II and Tier III individuals, and their relatively lower recruiting costs, make them increasingly attractive. Additionally, it has been shown that non-high school graduates and alternative credential-holders are more likely to reenlist, given successful completion of their first terms of enlistment.[38] Therefore, individuals categorized in Tier II and Tier III merit serious consideration for enlistment when their AFQT scores are sufficiently high. A refined Recruit Quality Matrix, such as the one introduced in Chapter V, could help identify low-cost subgroups within these tiers that promise to achieve acceptable levels of military success, while screening out subgroups currently eligible for enlistment that exhibit unacceptable levels of success. Rather than expanding the overall pool of potential enlistees, a matrix such as this could help to refine the current pool and ensure that the Navy's recruiting effort is as efficient and cost-effective as possible.

[38] Cooke and Quester, 249; Elster and Flyer, II-31.

C. FUTURE RESEARCH

1. Cost-Benefit Analysis

Although this research suggests that attrition can be reduced with a refined enlistment screening tool, a thorough cost-benefit analysis needs to be conducted to quantify the savings and to determine the extent to which persons with higher recruiting costs (A-Cell applicants) should be targeted. Generally, an analysis of this type should attempt to determine whether higher attrition rates associated with B cell recruits is justified by lower recruiting costs; and, conversely, whether higher recruiting costs for A-Cell and Cu-cell recruits is justified by the lower predicted attrition rates.

Another direction for future research would be to construct an optimization model to determine the right mix of A-Cell, B-Cell, and Cu-cell applicants. The optimization would attempt to maximize first-term completion, while minimizing the costs associated with recruiting, training, and attrition.

2. Alternative Measures of Military Success

This analysis concentrated on first-term attrition as the sole measure of military success. However, several other measures of success could be studied to see what impact they might have on a recruit-screening tool such as the one presented in Chapter V. For example, productivity, performance, and promotion are commonly accepted indicators of military success that should not be ignored. After all, if high aptitude Tier II recruits have completion rates on par with Tier I recruits, but they exhibit lower levels of within-grade productivity, then they are clearly not as

valuable; this would affect the degree to which Tier II recruits should be targeted for enlistment.

3. First-Term Attrition Analysis of Home School Graduates

Bootcamp attrition was analyzed in Chapter III. Home School graduates were included in that analysis because sufficient numbers appeared in the CNRC data set. On the other hand, the DMDC data set had too few home school graduates for statistically significant analysis. To assess first-term attrition, the data set also had to be at least four years old and could include only enlisted cohorts through fiscal year 1997. Home school graduates were still relatively rare among 1997 enlisted cohorts and they were placed in Tier II; so, there was not a great deal of attention directed toward this small, but growing, group.

However, as mentioned in Chapter IV, recruiting policy was changed in fiscal year 1998 when home school graduates were included in Tier I. Since they are now considered "high quality recruits," a lot more attention was devoted to them by recruiters, and they were recruited in greater numbers. For that reason, the CNRC data set, which includes enlisted cohorts from fiscal years 1998 through 2003, contains enough observations (N = 2,124) for meaningful analysis. The results of that analysis actually reveal that home school graduates have bootcamp attrition rates significantly higher than those of Tier II GED recipients and Tier III dropouts (See Chapter III). If this pattern holds when first-term attrition analysis can be conducted on this group, the Tier I status of home school graduates should be reconsidered to ensure that the Navy invests

appropriate resources and effort into recruiting this group.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A

Table 23. Logit Regression Results using Matrix Columns: 12-Month Attrition

Variable	Estimate	Std Error	P-Value
Intercept	-1.3789	0.0400	<.0001
Age	0.0358	1.74E-3	<.0001
Female	0.0564	0.0119	<.0001
Black	-0.2934	0.0121	<.0001
Hispanic	-0.2682	0.0154	<.0001
AIAN	0.1131	0.0403	0.0050
API	-0.7704	0.0309	<.0001
SWD	0.2858	0.0209	<.0001
MND	0.1472	0.0259	<.0001
MWD*	-0.0243	0.0256	0.3418
AFQTPerc	-8.82E-3	2.57E-4	<.0001
Waived	0.2108	9.20E-3	<.0001
E2	-0.2408	0.0164	<.0001
E3	-0.3478	0.0139	<.0001
MonDEP	-0.0979	4.70E-3	<.0001
DEPSq	4.51E-3	3.93E-4	<.0001
NoOption	0.1120	0.0124	<.0001
Column2	**0.5594**	**0.0163**	**<.0001**
Max Rescaled R-Square	0.0400		
Likelihood Ratio	9,865.7		
Pr>ChiSq	<0.0001		
N	401,681		

Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.
* Not statistically significant.

Table 24. Logit Regression Results using Educational Tiers: 12-Month Attrition

Variable	Estimate	Std Error	P-Value
Intercept	-1.3848	0.0400	<.0001
Age	0.0361	1.75E-3	<.0001
Female	0.0566	0.0119	<.0001
Black	-0.2933	0.0121	<.0001
Hispanic	-0.2683	0.0154	<.0001
AIAN	0.1134	0.0403	0.0048
API	-0.7708	0.0309	<.0001
SWD	0.2859	0.0209	<.0001
MND	0.1474	0.0259	<.0001
MWD*	-0.0238	0.0256	0.3498
AFQTPerc	-8.82E-3	2.57E-4	<.0001
Waived	0.2109	9.20E-3	<.0001
E2	-0.2409	0.0164	<.0001
E3	-0.3482	0.0139	<.0001
MonDEP	-0.0977	4.70E-3	<.0001
DEPSq	4.51E-3	3.93E-4	<.0001
NoOption	0.1117	0.0124	<.0001
Tier2	**0.5319**	**0.0207**	**<.0001**
Tier3	**0.5991**	**0.0244**	**<.0001**
Max Rescaled R-Square	0.0400		
Likelihood Ratio	9,870.5		
Pr>ChiSq	<0.0001		
N	401,681		

Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.
* Not statistically significant.

Table 25. Logit Regression Results using Matrix Columns: 24-Month Attrition

Variable	Estimate	Std Error	P-Value
Intercept	-0.5541	0.0356	<.0001
Age	0.0198	1.57E-3	<.0001
Female	0.1385	0.0103	<.0001
Black	-0.2306	0.0104	<.0001
Hispanic	-0.2697	0.0133	<.0001
AIAN	0.1442	0.0357	<.0001
API	-0.7910	0.0261	<.0001
SWD	0.2906	0.0189	<.0001
MND	0.0902	0.0233	0.0001
MWD	-0.0726	0.0230	0.0016
AFQTPerc	-8.63E-3	2.23E-4	<.0001
Waived	0.2453	8.06E-3	<.0001
E2	-0.2109	0.0140	<.0001
E3	-0.3207	0.0118	<.0001
MonDEP	-0.1122	4.08E-3	<.0001
DEPSq	5.29E-3	3.39E-4	<.0001
NoOption	0.1206	0.0109	<.0001
Column2	**0.7058**	**0.0149**	**<.0001**
Max Rescaled R-Square	0.0507		
Likelihood Ratio	14,211.5		
Pr>ChiSq	<0.0001		
N	401,681		

Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.

Table 26. Logit Regression Results using Educational Tiers: 24-Month Attrition

Variable	Estimate	Std Error	P-Value
Intercept	-0.5599	0.0357	<.0001
Age	0.0201	1.57E-3	<.0001
Female	0.1386	0.0103	<.0001
Black	-0.2304	0.0104	<.0001
Hispanic	-0.2698	0.0133	<.0001
AIAN	0.1445	0.0357	<.0001
API	-0.7914	0.0261	<.0001
SWD	0.2907	0.0189	<.0001
MND	0.0904	0.0233	0.0001
MWD	-0.0722	0.0230	0.0017
AFQTPerc	-8.63E-3	2.23E-4	<.0001
Waived	0.2454	8.06E-3	<.0001
E2	-0.2111	0.0140	<.0001
E3	-0.3212	0.0118	<.0001
MonDEP	-0.1120	4.08E-3	<.0001
DEPSq	5.29E-3	3.39E-4	<.0001
NoOption	0.1203	0.0109	<.0001
Tier2	**0.6768**	**0.0190**	**<.0001**
Tier3	**0.7476**	**0.0225**	**<.0001**
Max Rescaled R-Square	0.0507		
Likelihood Ratio	14,217.7		
Pr>ChiSq	<0.0001		
N	401,681		

Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.

Table 27. Logit Regression Results using Matrix Columns: 36-Month Attrition

Variable	Estimate	Std Error	P-Value
Intercept	-0.0229	0.0338	0.4969
Age	0.0105	1.49E-3	<.0001
Female	0.2059	9.59E-3	<.0001
Black	-0.1707	9.64E-3	<.0001
Hispanic	-0.2781	0.0124	<.0001
AIAN	0.1459	0.0341	<.0001
API	-0.8243	0.0238	<.0001
SWD	0.2814	0.0182	<.0001
MND	0.0702	0.0221	0.0015
MWD	-0.0613	0.0218	0.0049
AFQTPerc	-8.85E-3	2.08E-4	<.0001
Waived	0.2641	7.60E-3	<.0001
E2	-0.2029	0.0129	<.0001
E3	-0.3070	0.0108	<.0001
MonDEP	-0.1142	3.80E-3	<.0001
DEPSq	5.57E-3	3.14E-4	<.0001
NoOption	0.1083	0.0104	<.0001
Column2	**0.7721**	**0.0148**	**<.0001**
Max Rescaled R-Square	0.0560		
Likelihood Ratio	16,589.7		
Pr>ChiSq	<0.0001		
N	401,681		

Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.

Table 28. Logit Regression Results using Educational Tiers: 36-Month Attrition

Variable	Estimate	Std Error	P-Value
Intercept	-0.0311	0.0338	0.3585
Age	0.0109	1.49E-3	<.0001
Female	0.2061	9.59E-3	<.0001
Black	-0.1705	9.64E-3	<.0001
Hispanic	-0.2782	0.0124	<.0001
AIAN	0.1463	0.0341	<.0001
API	-0.8248	0.0238	<.0001
SWD	0.2816	0.0182	<.0001
MND	0.0705	0.0221	0.0014
MWD	-0.0608	0.0218	0.0052
AFQTPerc	-8.85E-3	2.08E-4	<.0001
Waived	0.2642	7.60E-3	<.0001
E2	-0.2031	0.0129	<.0001
E3	-0.3076	0.0108	<.0001
MonDEP	-0.1139	3.80E-3	<.0001
DEPSq	5.56E-3	3.14E-4	<.0001
NoOption	0.1080	0.0104	<.0001
Tier2	**0.7261**	**0.0189**	**<.0001**
Tier3	**0.8385**	**0.0225**	**<.0001**
Max Rescaled R-Square	0.0561		
Likelihood Ratio	16,605.2		
Pr>ChiSq	<0.0001		
N	401,681		

Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.

APPENDIX B

Table 29. Logit Regression Results using Educational Variables: 12-Month Attrition

Variable	Estimate	Std Error	P-Value
Intercept	-1.3990	0.0409	<.0001
Age	0.0345	1.80E-3	<.0001
Female	0.0624	0.0119	<.0001
Black	-0.2862	0.0121	<.0001
Hispanic	-0.2793	0.0154	<.0001
AIAN	0.1043	0.0403	0.0097
API	-0.7730	0.0309	<.0001
SWD	0.2687	0.0210	<.0001
MND	0.1383	0.0259	<.0001
MWD*	-0.0391	0.0256	0.1270
AFQTPerc	-8.46E-3	2.57E-4	<.0001
Waived	0.2015	9.22E-3	<.0001
E2	-0.2648	0.0166	<.0001
E3	-0.3256	0.0144	<.0001
MonDEP	-0.0987	4.70E-3	<.0001
DEPSq	4.71E-3	3.93E-4	<.0001
NoOption	0.1115	0.0124	<.0001
Dropout3	**0.6266**	**0.0244**	**<.0001**
Cert2	**0.5956**	**0.0680**	**<.0001**
GED2	**0.5595**	**0.0217**	**<.0001**
Adult1	**0.4182**	**0.0231**	**<.0001**
CollSem1	**0.4797**	**0.0274**	**<.0001**
Assoc1*	**-3.43E-3**	**0.0541**	**0.9495**
Bach1	**-0.1656**	**0.0460**	**0.0003**
Max Rescaled R-Square	0.0424		
Likelihood Ratio	10,464.9		
Pr>ChiSq	<0.0001		
N	401,681		

Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.
* Not statistically significant.

Table 30. Logit Regression Results using Educational Variables: 24-Month Attrition

Variable	Estimate	Std Error	P-Value
Intercept	-0.5752	0.0366	<.0001
Age	0.0182	1.62E-3	<.0001
Female	0.1463	0.0103	<.0001
Black	-0.2224	0.0104	<.0001
Hispanic	-0.2833	0.0133	<.0001
AIAN	0.1338	0.0358	0.0002
API	-0.7961	0.0262	<.0001
SWD	0.2705	0.0190	<.0001
MND	0.0797	0.0234	0.0006
MWD	-0.0910	0.0230	<.0001
AFQTPerc	-8.23E-3	2.24E-4	<.0001
Waived	0.2344	8.09E-3	<.0001
E2	-0.2379	0.0142	<.0001
E3	-0.2938	0.0122	<.0001
MonDEP	-0.1133	4.08E-3	<.0001
DEPSq	5.54E-3	3.39E-4	<.0001
NoOption	0.1203	0.0110	<.0001
Dropout3	**0.7802**	**0.0225**	**<.0001**
Cert2	**0.7539**	**0.0609**	**<.0001**
GED2	**0.7088**	**0.0199**	**<.0001**
Adult1	**0.5259**	**0.0209**	**<.0001**
CollSem1	**0.5806**	**0.0249**	**<.0001**
Assoc1*	**-0.0621**	**0.0475**	**0.1907**
Bach1	**-0.1694**	**0.0396**	**<.0001**
Max Rescaled R-Square	0.0547		
Likelihood Ratio	15,343.1		
Pr>ChiSq	<0.0001		
N	401,681		

Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.
* Not statistically significant.

Table 31. Logit Regression Results using Educational Variables: 36-Month Attrition

Variable	Estimate	Std Error	P-Value
Intercept	-0.0502	0.0347	0.1482
Age	9.15E-3	1.54E-3	<.0001
Female	0.2142	9.61E-3	<.0001
Black	-0.1623	9.67E-3	<.0001
Hispanic	-0.2925	0.0124	<.0001
AIAN	0.1351	0.0342	<.0001
API	-0.8311	0.0238	<.0001
SWD	0.2603	0.0183	<.0001
MND	0.0595	0.0222	0.0074
MWD	-0.0811	0.0219	0.0002
AFQTPerc	-8.45E-3	2.09E-4	<.0001
Waived	0.2530	7.62E-3	<.0001
E2	-0.2308	0.0131	<.0001
E3	-0.2788	0.0111	<.0001
MonDEP	-0.1152	3.81E-3	<.0001
DEPSq	5.81E-3	3.14E-4	<.0001
NoOption	0.1079	0.0104	<.0001
Dropout3	**0.8717**	**0.0225**	**<.0001**
Cert2	**0.8360**	**0.0597**	**<.0001**
GED2	**0.7549**	**0.0198**	**<.0001**
Adult1	**0.5573**	**0.0204**	**<.0001**
CollSem1	**0.6255**	**0.0244**	**<.0001**
Assoc1*	**-0.0575**	**0.0437**	**0.1890**
Bach1	**-0.2039**	**0.0366**	**<.0001**
Max Rescaled R-Square	0.0607		
Likelihood Ratio	17,994.5		
Pr>ChiSq	<0.0001		
N	401,681		

Source: Derived from data provided by Commander, Navy Recruiting Command (CNRC), 2003.
* Not statistically significant.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX C

Table 32. Predicted Probability of 48-Month Completion: Dropout3

Intercept	+	Dropout3	+	AFQT perc	*	AFQT coeff	=	Log-Odds (Attrite48)	Prob[a] (Attrite48)	Prob[b] (Complete48)
0.1928	+	1.0247	+	**31**	*	-.00963	=	**0.919**	**0.715**	**0.285**
0.1928	+	1.0247	+	**35**	*	-.00963	=	**0.880**	**0.707**	**0.293**
0.1928	+	1.0247	+	**40**	*	-.00963	=	**0.832**	**0.697**	**0.303**
0.1928	+	1.0247	+	**50**	*	-.00963	=	**0.736**	**0.676**	**0.324**
0.1928	+	1.0247	+	**55**	*	-.00963	=	**0.688**	**0.665**	**0.335**
0.1928	+	1.0247	+	**60**	*	-.00963	=	**0.640**	**0.655**	**0.345**
0.1928	+	1.0247	+	**65**	*	-.00963	=	**0.592**	**0.644**	**0.356**
0.1928	+	1.0247	+	**70**	*	-.00963	=	**0.543**	**0.633**	**0.367**
0.1928	+	1.0247	+	**75**	*	-.00963	=	**0.495**	**0.621**	**0.379**
0.1928	+	1.0247	+	**80**	*	-.00963	=	**0.447**	**0.610**	**0.390**
0.1928	+	1.0247	+	**85**	*	-.00963	=	**0.399**	**0.598**	**0.402**
0.1928	+	1.0247	+	**90**	*	-.00963	=	**0.351**	**0.587**	**0.413**
0.1928	+	1.0247	+	**95**	*	-.00963	=	**0.303**	**0.575**	**0.425**
0.1928	+	1.0247	+	**99**	*	-.00963	=	**0.264**	**0.566**	**0.434**

Source: Derived from Results in Table 22.
[a] P(Attrite48) = 1/(1+EXP[Log-Odds(Attrite48)])
[b] P(Complete48) = 1 – P(Attrite48)

Table 33. Predicted Probability of 48-Month Completion: GED2

Intercept	+	GED2	+	AFQT perc	*	AFQT coeff	=	Log-Odds (Attrite48)	Prob[a] (Attrite48)	Prob[b] (Complete48)
0.1928	+	0.9246	+	**31**	*	-.00963	=	**0.819**	**0.694**	**0.306**
0.1928	+	0.9246	+	**35**	*	-.00963	=	**0.780**	**0.686**	**0.314**
0.1928	+	0.9246	+	**40**	*	-.00963	=	**0.732**	**0.675**	**0.325**
0.1928	+	0.9246	+	**50**	*	-.00963	=	**0.636**	**0.654**	**0.346**
0.1928	+	0.9246	+	**55**	*	-.00963	=	**0.588**	**0.643**	**0.357**
0.1928	+	0.9246	+	**60**	*	-.00963	=	**0.540**	**0.632**	**0.368**
0.1928	+	0.9246	+	**65**	*	-.00963	=	**0.491**	**0.620**	**0.380**
0.1928	+	0.9246	+	**70**	*	-.00963	=	**0.443**	**0.609**	**0.391**
0.1928	+	0.9246	+	**75**	*	-.00963	=	**0.395**	**0.598**	**0.402**
0.1928	+	0.9246	+	**80**	*	-.00963	=	**0.347**	**0.586**	**0.414**
0.1928	+	0.9246	+	**85**	*	-.00963	=	**0.299**	**0.574**	**0.426**
0.1928	+	0.9246	+	**90**	*	-.00963	=	**0.251**	**0.562**	**0.438**
0.1928	+	0.9246	+	**95**	*	-.00963	=	**0.203**	**0.550**	**0.450**
0.1928	+	0.9246	+	**99**	*	-.00963	=	**0.164**	**0.541**	**0.459**

Source: Derived from Results in Table 22.
[a] P(Attrite48) = 1/(1+EXP[Log-Odds(Attrite48)])
[b] P(Complete48) = 1 – P(Attrite48)

Table 34. Predicted Probability of 48-Month Completion: Cert2

Intercept	+	Cert2	+	AFQT perc	*	AFQT coeff	=	Log-Odds (Attrite48)	Prob[a] (Attrite48)	Prob[b] (Complete48)
0.1928	+	0.8034	+	**31**	*	-.00963	=	**0.698**	**0.668**	**0.332**
0.1928	+	0.8034	+	**35**	*	-.00963	=	**0.659**	**0.659**	**0.341**
0.1928	+	0.8034	+	**40**	*	-.00963	=	**0.611**	**0.648**	**0.352**
0.1928	+	0.8034	+	**50**	*	-.00963	=	**0.515**	**0.626**	**0.374**
0.1928	+	0.8034	+	**55**	*	-.00963	=	**0.467**	**0.615**	**0.385**
0.1928	+	0.8034	+	**60**	*	-.00963	=	**0.418**	**0.603**	**0.397**
0.1928	+	0.8034	+	**65**	*	-.00963	=	**0.370**	**0.592**	**0.408**
0.1928	+	0.8034	+	**70**	*	-.00963	=	**0.322**	**0.580**	**0.420**
0.1928	+	0.8034	+	**75**	*	-.00963	=	**0.274**	**0.568**	**0.432**
0.1928	+	0.8034	+	**80**	*	-.00963	=	**0.226**	**0.556**	**0.444**
0.1928	+	0.8034	+	**85**	*	-.00963	=	**0.178**	**0.544**	**0.456**
0.1928	+	0.8034	+	**90**	*	-.00963	=	**0.130**	**0.532**	**0.468**
0.1928	+	0.8034	+	**95**	*	-.00963	=	**0.081**	**0.520**	**0.480**
0.1928	+	0.8034	+	**99**	*	-.00963	=	**0.043**	**0.511**	**0.489**

Source: Derived from Results in Table 22.
[a] P(Attrite48) = 1/(1+EXP[Log-Odds(Attrite48)])
[b] P(Complete48) = 1 – P(Attrite48)

Table 35. Predicted Probability of 48-Month Completion: CollSem1

Intercept	+	CollSem1	+	AFQT perc	*	AFQT coeff	=	Log-Odds (Attrite48)	Prob[a] (Attrite48)	Prob[b] (Complete48)
0.1928	+	0.6123	+	**31**	*	-.00963	=	**0.507**	**0.624**	**0.376**
0.1928	+	0.6123	+	**35**	*	-.00963	=	**0.468**	**0.615**	**0.385**
0.1928	+	0.6123	+	**40**	*	-.00963	=	**0.420**	**0.603**	**0.397**
0.1928	+	0.6123	+	**50**	*	-.00963	=	**0.324**	**0.580**	**0.420**
0.1928	+	0.6123	+	**55**	*	-.00963	=	**0.275**	**0.568**	**0.432**
0.1928	+	0.6123	+	**60**	*	-.00963	=	**0.227**	**0.557**	**0.443**
0.1928	+	0.6123	+	**65**	*	-.00963	=	**0.179**	**0.545**	**0.455**
0.1928	+	0.6123	+	**70**	*	-.00963	=	**0.131**	**0.533**	**0.467**
0.1928	+	0.6123	+	**75**	*	-.00963	=	**0.083**	**0.521**	**0.479**
0.1928	+	0.6123	+	**80**	*	-.00963	=	**0.035**	**0.509**	**0.491**
0.1928	+	0.6123	+	**85**	*	-.00963	=	**-0.013**	**0.497**	**0.503**
0.1928	+	0.6123	+	**90**	*	-.00963	=	**-0.062**	**0.485**	**0.515**
0.1928	+	0.6123	+	**95**	*	-.00963	=	**-0.110**	**0.473**	**0.527**
0.1928	+	0.6123	+	**99**	*	-.00963	=	**-0.148**	**0.463**	**0.537**

Source: Derived from Results in Table 22.
[a] P(Attrite48) = 1/(1+EXP[Log-Odds(Attrite48)])
[b] P(Complete48) = 1 – P(Attrite48)

Table 36. Predicted Probability of 48-Month Completion: Adult1

Intercept	+	Adult1	+	AFQT perc	*	AFQT coeff	=	Log-Odds (Attrite48)	Prob[a] (Attrite48)	Prob[b] (Complete48)
0.1928	+	0.5945	+	**31**	*	-.00963	=	**0.489**	**0.620**	**0.380**
0.1928	+	0.5945	+	**35**	*	-.00963	=	**0.450**	**0.611**	**0.389**
0.1928	+	0.5945	+	**40**	*	-.00963	=	**0.402**	**0.599**	**0.401**
0.1928	+	0.5945	+	**50**	*	-.00963	=	**0.306**	**0.576**	**0.424**
0.1928	+	0.5945	+	**55**	*	-.00963	=	**0.258**	**0.564**	**0.436**
0.1928	+	0.5945	+	**60**	*	-.00963	=	**0.210**	**0.552**	**0.448**
0.1928	+	0.5945	+	**65**	*	-.00963	=	**0.161**	**0.540**	**0.460**
0.1928	+	0.5945	+	**70**	*	-.00963	=	**0.113**	**0.528**	**0.472**
0.1928	+	0.5945	+	**75**	*	-.00963	=	**0.065**	**0.516**	**0.484**
0.1928	+	0.5945	+	**80**	*	-.00963	=	**0.017**	**0.504**	**0.496**
0.1928	+	0.5945	+	**85**	*	-.00963	=	**-0.031**	**0.492**	**0.508**
0.1928	+	0.5945	+	**90**	*	-.00963	=	**-0.079**	**0.480**	**0.520**
0.1928	+	0.5945	+	**95**	*	-.00963	=	**-0.128**	**0.468**	**0.532**
0.1928	+	0.5945	+	**99**	*	-.00963	=	**-0.166**	**0.459**	**0.541**

Source: Derived from Results in Table 22.
[a] P(Attrite48) = 1/(1+EXP[Log-Odds(Attrite48)])
[b] P(Complete48) = 1 – P(Attrite48)

Table 37. Predicted Probability of 48-Month Completion: HSGrad1

Intercept	+	HSGrad1[a]	+	AFQT perc	*	AFQT coeff	=	Log-Odds (Attrite48)	Prob[b] (Attrite48)	Prob[c] (Complete48)
0.1928	+	0	+	**31**	*	-.00963	=	**-0.106**	**0.474**	**0.526**
0.1928	+	0	+	**35**	*	-.00963	=	**-0.144**	**0.464**	**0.536**
0.1928	+	0	+	**40**	*	-.00963	=	**-0.192**	**0.452**	**0.548**
0.1928	+	0	+	**50**	*	-.00963	=	**-0.289**	**0.428**	**0.572**
0.1928	+	0	+	**55**	*	-.00963	=	**-0.337**	**0.417**	**0.583**
0.1928	+	0	+	**60**	*	-.00963	=	**-0.385**	**0.405**	**0.595**
0.1928	+	0	+	**65**	*	-.00963	=	**-0.433**	**0.393**	**0.607**
0.1928	+	0	+	**70**	*	-.00963	=	**-0.481**	**0.382**	**0.618**
0.1928	+	0	+	**75**	*	-.00963	=	**-0.529**	**0.371**	**0.629**
0.1928	+	0	+	**80**	*	-.00963	=	**-0.578**	**0.359**	**0.641**
0.1928	+	0	+	**85**	*	-.00963	=	**-0.626**	**0.348**	**0.652**
0.1928	+	0	+	**90**	*	-.00963	=	**-0.674**	**0.338**	**0.662**
0.1928	+	0	+	**95**	*	-.00963	=	**-0.722**	**0.327**	**0.673**
0.1928	+	0	+	**99**	*	-.00963	=	**-0.761**	**0.319**	**0.681**

Source: Derived from Results in Table 22.
[a] HS Grad is the base case, therefore no coefficient.
[b] P(Attrite48) = 1/(1+EXP[Log-Odds(Attrite48)])
[c] P(Complete48) = 1 – P(Attrite48)

Table 38. Predicted Probability of 48-Month Completion: Assoc1

Intercept	+	Assoc1	+	AFQT perc	*	AFQT coeff	=	Log-Odds (Attrite48)	Prob[a] (Attrite48)	Prob[b] (Complete48)
0.1928	+	-0.172	+	**31**	*	-.00963	=	**-0.277**	**0.431**	**0.569**
0.1928	+	-0.172	+	**35**	*	-.00963	=	**-0.316**	**0.422**	**0.578**
0.1928	+	-0.172	+	**40**	*	-.00963	=	**-0.364**	**0.410**	**0.590**
0.1928	+	-0.172	+	**50**	*	-.00963	=	**-0.460**	**0.387**	**0.613**
0.1928	+	-0.172	+	**55**	*	-.00963	=	**-0.509**	**0.376**	**0.624**
0.1928	+	-0.172	+	**60**	*	-.00963	=	**-0.557**	**0.364**	**0.636**
0.1928	+	-0.172	+	**65**	*	-.00963	=	**-0.605**	**0.353**	**0.647**
0.1928	+	-0.172	+	**70**	*	-.00963	=	**-0.653**	**0.342**	**0.658**
0.1928	+	-0.172	+	**75**	*	-.00963	=	**-0.701**	**0.332**	**0.668**
0.1928	+	-0.172	+	**80**	*	-.00963	=	**-0.749**	**0.321**	**0.679**
0.1928	+	-0.172	+	**85**	*	-.00963	=	**-0.797**	**0.311**	**0.689**
0.1928	+	-0.172	+	**90**	*	-.00963	=	**-0.846**	**0.300**	**0.700**
0.1928	+	-0.172	+	**95**	*	-.00963	=	**-0.894**	**0.290**	**0.710**
0.1928	+	-0.172	+	**99**	*	-.00963	=	**-0.932**	**0.282**	**0.718**

Source: Derived from Results in Table 22.
[a] P(Attrite48) = 1/(1+EXP[Log-Odds(Attrite48)])
[b] P(Complete48) = 1 – P(Attrite48)

Table 39. Predicted Probability of 48-Month Completion: Bach1

Intercept	+	Bach1	+	AFQT perc	*	AFQT coeff	=	Log-Odds (Attrite48)	Prob[a] (Attrite48)	Prob[b] (Complete48)
0.1928	+	-0.229	+	**31**	*	-.00963	=	**-0.335**	**0.417**	**0.583**
0.1928	+	-0.229	+	**35**	*	-.00963	=	**-0.373**	**0.408**	**0.592**
0.1928	+	-0.229	+	**40**	*	-.00963	=	**-0.421**	**0.396**	**0.604**
0.1928	+	-0.229	+	**50**	*	-.00963	=	**-0.518**	**0.373**	**0.627**
0.1928	+	-0.229	+	**55**	*	-.00963	=	**-0.566**	**0.362**	**0.638**
0.1928	+	-0.229	+	**60**	*	-.00963	=	**-0.614**	**0.351**	**0.649**
0.1928	+	-0.229	+	**65**	*	-.00963	=	**-0.662**	**0.340**	**0.660**
0.1928	+	-0.229	+	**70**	*	-.00963	=	**-0.710**	**0.330**	**0.670**
0.1928	+	-0.229	+	**75**	*	-.00963	=	**-0.758**	**0.319**	**0.681**
0.1928	+	-0.229	+	**80**	*	-.00963	=	**-0.807**	**0.309**	**0.691**
0.1928	+	-0.229	+	**85**	*	-.00963	=	**-0.855**	**0.298**	**0.702**
0.1928	+	-0.229	+	**90**	*	-.00963	=	**-0.903**	**0.288**	**0.712**
0.1928	+	-0.229	+	**95**	*	-.00963	=	**-0.951**	**0.279**	**0.721**
0.1928	+	-0.229	+	**99**	*	-.00963	=	**-0.989**	**0.271**	**0.729**

Source: Derived from Results in Table 22.
[a] P(Attrite48) = 1/(1+EXP[Log-Odds(Attrite48)])
[b] P(Complete48) = 1 – P(Attrite48)

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California

3. LCDR Harry Barber
   Navy Recruiting Command
   Millington, Tennessee

4. Dr. John Noble
   Navy Recruiting Command
   Millington, Tennessee

5. Prof. Stephen Mehay
   Naval Postgraduate School
   Monterey, California

6. Prof. Mark Eitelberg
   Naval Postgraduate School
   Monterey, California

7. CDR William Hatch
   Naval Postgraduate School
   Monterey, California

8. LCDR Christopher Bownds
   Navy Personnel Command
   Millington, Tennessee