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THESIS

AN ANALYSIS OF THE IMPACT OF FULLY FUNDED GRADUATE EDUCATION ON THE RETENTION OF NAVAL OFFICERS

by

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December 1999

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This thesis investigates the impact of "funded graduate education" on retention of Naval Officers. Logit regression and multivariate models were used to determine the effects that a graduate degree from the Naval Postgraduate School (fully funded) or civilian graduate schools through partially funded graduate programs had on officer retention. The data sets were created using data from the Officer Master Record Files (OMRF) obtained from the Defense Manpower Data Center, Monterey, California (DMDC). The data sets included all Naval Officers that were eligible for voluntary separation each year from 1992 to 1997.

Maximum likelihood logit regression was used to estimate the probabilities that officers with graduate degrees earned from NPS or civilian institutions decide to leave the service at the end of any mandatory educational obligation. The findings revealed indicate that although funded graduate education may have an effect on promotion possibilities, its impact on retention past the ten-year point in an officer's career is not detectable.

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AN ANALYSIS OF THE IMPACT OF FULLY FUNDED GRADUATE EDUCATION ON THE RETENTION OF NAVAL OFFICERS

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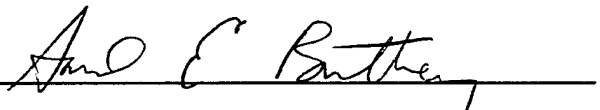
Approved by: 

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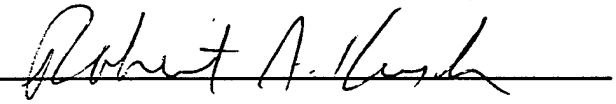

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ABSTRACT

This thesis investigates the impact of "funded graduate education" on retention of Naval Officers. Logit regression and multivariate models were used to determine the effects that a graduate degree from the Naval Postgraduate School (fully funded) or civilian graduate schools through partially funded graduate programs had on officer retention. The data sets were created using data from the Officer Master Record Files (OMRF) obtained from the Defense Manpower Data Center, Monterey, California (DMDC). The data sets included all Naval Officers that were eligible for voluntary separation each year from 1992 to 1997.

Maximum likelihood logit regression was used to estimate the probabilities that officers with graduate degrees earned from NPS or civilian institutions decide to leave the service at the end of any mandatory educational obligation. The findings revealed indicate that although funded graduate education may have an effect on promotion possibilities, its impact on retention past the ten-year point in an officer's career is not detectable.

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EXECUTIVE SUMMARY

The Navy is experiencing low retention rates for officers in almost every community within the Navy. Current unemployment rates are very low, allowing more officers to leave the service virtually guaranteed to have a job waiting for him or her. The Navy invests significant resources in junior officers in the anticipation that a percentage of these officers will remain in the Navy until retirement. One of the investments the Navy makes is to provide graduate education to some of its officers through the Naval Postgraduate School (fully funded) or through a partially funded program. This thesis investigates the impact of "funded graduate education" on retention of Naval Officers.

Several civilian studies have examined the relationship between graduate education and job performance. In the past ten years no fewer than four Master's theses at NPS have analyzed the relationship between graduate education and performance or promotion probability in the Navy (Jordan, 1991; Talaga, 1994; Buterbaugh, 1995; Fuchs, 1996). The findings of previous research support the contention that a Naval Officer with graduate education, specifically fully funded graduate education, is promoted at a statistically higher rate and also remains in the Navy to the ten-year mark at a statistically higher rate. However, little work has been done to analyze whether participation in graduate level education programs has any effect on an officer's decision to stay in the service past the ten-year point.

This thesis used logistic regression techniques to identify factors that affect retention of Naval Officers, on a year-to-year basis, serving between 1992 and 1997. The data sets used for this analysis were obtained from the Officer Master File database maintained at the Defense Manpower Data Center, Monterey, California. The Officer

Master File (OMF) has over 300 fields of longitudinal information on the careers of all officers in the Navy and Naval Reserve, and is indexed by Social Security Number. The fields of interest for this thesis were demographic data such as sex, race, marital status, education (level of education, schools attended), and subspecialty codes earned. Officers who left the service involuntarily, retired, or had obligated service due to postgraduate education were removed from the data sets to capture the target population, those officers with the opportunity to voluntarily leave the Navy in a given year.

It is extremely difficult to model human behavior for a single individual. However, it is possible to see trends from a large number of individuals that form a group. A funded graduate education does not appear to have a substantial effect on retention past obligated service lengths, but it is true that the proportion of officers with funded Master's Degrees leaving the Navy is consistently lower than that of those who earn a Master's Degree on their own or have only a Bachelor's Degree.

I. INTRODUCTION

> [Graduate] Students will expand their breadth of knowledge in a particular discipline and will reinvigorate their ability to successfully analyze and solve the complex challenges we face. These important skills will help guide our Navy into the 21st century through fresh thinking and innovation.
>
> Our Navy is the world's best. The richly rewarding educational experience of attending the Naval Postgraduate School will help its graduates maintain that status while producing our Navy's future leaders.
>
> -- ADM J. L. Johnson, Chief of Naval Operations, on graduate education policy. (NPS Catalog Academic Year 1999, p.6)

A. BACKGROUND

The importance of graduate education has been emphasized by the current Chief of Naval Operations, just as it has been by each of his predecessors in the 1990's. Taking this into account, several theses written at the Naval Postgraduate School (NPS) investigate the benefit of a postgraduate degree to officers in various communities of the Navy (Jordan, 1991; Fuchs, 1994). Specifically, these theses evaluated the effects of postgraduate education on performance and promotion of Surface Warfare Officers and General Unrestricted Line officers of the U. S. Navy after they received a government-funded postgraduate education leading to Master's Degrees. Previous research had not thoroughly examined the effect that graduate education has on retention of personnel past the mandatory obligated service incurred for accepting a government funded education.

A study by the Center for Naval Analyses (CNA) (1998) extensively examined the effects of voluntary education on the performance, promotion, and retention of enlisted personnel. The CNA study focused primarily on two programs: (1) Tuition Assistance and (2) The Program for Afloat College Education. Both programs provide assistance for education that is obtained on a service member's personal time. Officers

have the same opportunity as enlisted personnel to use Tuition Assistance to help attain their higher education goals. Additionally, some officers are offered a fully funded graduate education at NPS. It is possible to use methods similar to those of the CNA study when analyzing officer educational programs even though the programs are significantly different. The study of officers is slightly more complicated than that of enlisted personnel because of the officers' irregular service lengths. Enlisted personnel sign up for a specific length of time, at the end of which they either re-enlist or decide to leave the Navy. For officers, analysis of the retention problem is more complicated, because after any initial obligation that an officer may have, he or she is, typically, free to resign his or her commission at any time. Certain assignments, like funded graduate education, extend that obligation for varying amounts of time depending on the length of training.

In order to generate useful results, the officers who leave the service voluntarily before reaching "time in service to retire" must be examined to see if there is a significant difference between officers who receive funded graduate education and those who do not. Part of the Navy's amortization of the cost of funding graduate education for officers is to have graduate educated officers serve a tour in a job using their postgraduate specialty. Since many officers do not go immediately to billets that use their postgraduate specialty, it is possible that the Navy may never get the opportunity to benefit directly from providing this funded education.

B. THESIS OBJECTIVES

This thesis analyzes the effects of funded graduate education on the retention of Naval Officers. The data used in this study was taken from the Officer Master File for

fiscal years 1982-1998, and comprised all naval officers in ranks Lieutenant (O-3) through Captain (O-6) with fewer than thirty years of service. The information from the Officer Master File was broken down into seven yearly subsets. Each of these subsets was organized into two groups: those officers who left the service voluntarily during a particular year and those who chose to remain on active duty throughout the year. The overall goal of the study was to determine if there is significant difference in the proportion of personnel with and without funded graduate education who leave the service each year.

C. ORGANIZATION

Chapter II provides descriptions of the postgraduate education system in the Navy and previous studies of graduate education. Chapter III describes the formulation and content of the data sets used for this analysis as well as explains the statistical models used for the study. Chapter IV presents the results of the analysis. Chapter V summarizes the results of the analysis, provides conclusions and recommends further research.

II. LITERATURE REVIEW

A. HISTORY OF NAVAL POSTGRADUATE EDUCATION

The Navy has provided graduate level education to its officers since the early years of the Twentieth Century. In June 1909, not long after the return of the Great White Fleet from its trip around the globe, the Secretary of the Navy established a school of marine engineering at the United States Naval Academy, Annapolis, Maryland. What started out as ten officer students and two Navy instructors evolved into the foundation of what we now call NPS. For forty-two years the Postgraduate Department of the Naval Academy, as it was then called, came under the administration of the Naval Academy Superintendent. During this time the school began to take on a life of its own. After World War II, Congress passed legislation to make NPS a fully accredited, degree-granting institution. Shortly thereafter, Congress decided to move NPS to its own campus. In 1951, the Postgraduate Department of the United States Naval Academy officially moved to Monterey, California to become the Naval Postgraduate School. By the early 1950's, NPS had grown to about 500 students. NPS did not stop its growth there; the student population at the Postgraduate School has expanded to 1,500, with students coming from all service branches and many other nations. The course of study has grown as well over the years, from a study only of marine engineering to more than forty programs of study, ranging from the traditional engineering and physical sciences to the emerging technology of Information Warfare. (Sanders, 1997)

Attending NPS, however, is not the only way for officers to obtain graduate education. The Civilian Institution Program allows officers to attend civilian universities full time to study curricula that do not necessarily have a direct Navy focus, but are

sanctioned by the Navy for certain programs, such as Ocean Engineering at the University of California, Berkeley or International Law at Harvard University. Officers who attend NPS or a civilian university under the Civilian Institution Program are, for purposes of this study, considered as fully funded graduate education recipients. It is important to note that an officer is not limited to these two options when considering graduate education. If an officer wishes to pursue graduate education but does not desire a fully funded program, he or she may attend a university of his or her choice during evenings, on weekends, or after duty, using partial funding programs like the Montgomery G.I. Bill or Tuition Assistance. The main difference between a fully funded graduate degree and a partially or non-funded graduate program lies in the assignment of a Navy subspecialty designation. All fully funded graduate programs give a subspecialty code designating the officer for future assignment in his or her field of study. Since NPS makes up the vast majority of fully funded graduate students each year, for purposes of this thesis officers with a subspecialty code will be broken into two groups: those who went to NPS and those who obtained their graduate degrees elsewhere.

B. SUBSPECIALTY CODING AND FUTURE ASSIGNMENT

An officer who completes a fully funded graduate education program receives a five-character subspecialty code. In this thesis the subspecialty codes of interest are those known as p-codes and q-codes. P- and q-coded billets "require extensive knowledge of theories, principles, processes and/or techniques certified through the acquisition of the master's degree for optimum performance of duty."(BUPERS, 1999, p.37) Q-coded billets have the additional requirement of significant professional experience in the area of specialty. These q-codes are for "proven subspecialists" in the Fleet Support

community, Medical Service Corps and Nurse Corps only. The subspecialty system was developed as the foundation for generating the Navy's postgraduate education requirements. The system tracks billets that require special knowledge, as well as officers who possess specific knowledge in that field. The Navy categorizes billets and officers by using a five-character code that contains the functional field of the subspecialty, the educational field and the educational level. The first two characters are "00" for all subspecialty codes except for certain unique Staff Corps billets (i.e. Medical Corps, Chaplain Corps, etc.) The second two characters identify the educational discipline, and the final character denotes the level of education. For example a line officer with a Master's Degree in Operations Research has a subspecialty code of "0042P" while a Medical Service Corps officer with a Master's Degree and significant previous experience in Biochemistry would have a subspecialty code of "1810Q". The subspecialty code allows for matching billets with officers and the tracking of those officers. (BUPERS, 1999, p.28)

The Navy's Subspecialty Requirements Review board makes the decision as to whether a billet requires a subspecialty code as a prerequisite. This board holds meetings for each subspecialty and provides a quality check that qualified p- and q-coded officers are used in billets that require specialized knowledge. A review of the curricula of all subspecialty programs is conducted every two years to ensure that the skills acquired by officers are in line with the needs of the Navy. The Curricular Officers at NPS and the Primary Consultants for the subspecialty conduct the reviews. Primary Consultants are major branches within the Department of the Navy. For example, the Primary Consultant for Operations Analysis is N-81, which is the assessment division of the office of the

Deputy CNO for Resources, Warfare Requirements, and Assessments. These reviews provide the system with a check to maintain reliable education in the preferred areas of study. (BUPERS, 1993)

The annual quota of officers to be offered graduate education is driven by the number of p- and q coded billets in the Navy. The model used by the Bureau of Naval Personnel establishes the flow of new officers needed for each subspecialty each year. After an officer receives a p- or q- code the Department of Defense requires the service to carefully manage his or her further assignments. Department of Defense directive 1322.10 ("Policies on Graduate Education for Military Officers") requires that an officer serve a "payback" tour within two tours after receiving funded graduate education. This payback tour must be in a position related to the area of graduate study.

C. PREVIOUS STUDIES

Many civilian studies have examined the relationship between graduate education and job performance. In the past ten years no fewer than four Master's theses at NPS have analyzed the relationship between graduate education and performance or promotion probability in the Navy (Jordan, 1991; Talaga, 1994; Buterbaugh, 1995; Fuchs, 1996). However, little work has been done to analyze whether participation in graduate level education programs has any effect on an officer's proclivity to leave the service.

The CNA study (1998) analyzed the Navy's Voluntary Education program for enlisted Sailors with respect to promotion, cross-rating, and retention of Sailors as well as provided cost-benefit analyses for the various Voluntary Education programs. The primary focus of the report was the impact of the Tuition Assistance program, Program

for Afloat College Education, and Academic Skills Learning Centers on the careers of enlisted Sailors. To model the effects of voluntary education the authors used a binomial probit model. The dependent variable was whether the first-term Sailor re-enlisted (or extended) or not. The fiscal year 1992 cohort of four-year enlistees was tracked through their first re-enlistment decision. Sailors who did not re-enlist included Sailors who left early as well as those who left upon completion of their contract terms. The retention model showed that Sailors who participated in college Voluntary Education programs had significantly higher re-enlistment rates than non-participants. Surprisingly, Sailors with as few as fifteen college credits proved 7 percent more likely to re-enlist and those with 60 college credits were 25 percent more likely to re-enlist (over the baseline 30 percent of all personnel reenlisting in the cohort.).

Jordan (1991) modeled the effect of graduate education and background factors on the retention to the Lieutenant Commander (O-4) and Commander (O-5) Selection Boards. The focus of Jordan's thesis was the General Unrestricted Line community, which later became part of the Fleet Support community. Using the Officer Promotion History File and the Officer Master Loss File for fiscal years 1981 through 1990 samples of sizes 2,345 and 790 were obtained for the Lieutenant Commander and Commander retention models, respectively. Based on multivariate logistic regression models, Jordan found that graduate education had a positive impact on the probability of retention through the Lieutenant Commander Selection Board. However, since the Commander data set had a very small number of officers who left voluntarily, the results of the Commander retention model were deemed unreliable. Jordan's Lieutenant Commander retention model illustrated that General Unrestricted Line Officers with NPS Master's

Degrees are statistically more inclined to remain in the Navy until the Lieutenant Commander Selection Board. The model showed that "an officer with an NPS degree is 37% less likely to leave the Navy than an officer with no degree." (Jordan, 1991, p.54) What was not taken into account in this model was the obligated service that is incurred for attending NPS. Most officers who attend NPS have already served at least five years in the Navy and have reached the rank of Lieutenant. When an officer attends NPS or receives other funding for postgraduate education there is a minimum time that he or she must continue to serve before being able to leave the Navy. For an officer who completes a two-year curriculum the obligation is three additional years of service after graduation. That means that an officer who has five years of prior service followed by two years of graduate education, and then serves three more years typically has served for at least ten years in the Navy when the first opportunity to leave arises. It is also at this ten-year point that the officer is eligible for evaluation by the Lieutenant Commander Selection Board. Therefore, it is not surprising that a Master's Degree from NPS or another funded graduate program would significantly impact this retention figure.

Fuchs (1996) was concerned primarily with the effects of graduate education on promotion and subsequent screening for command in the Surface Warfare Officer community. In discussing the utilization of officers and the Navy's investment in human capital, Fuchs found that the "percentages indicate that 99 percent of the officers with fully funded graduate education stay to the ten-year point." (Fuchs, 1996, p.30) He compared this to a 38 percent retention rate for Naval Officers who do not posses graduate degrees. Again if the typical officer who attends NPS is obligated until the ten-year point, the quoted retention statistic would not be out of the ordinary. If the focus of

the time period were to be shifted to the fifteen-year mark it would presumably show a drop from the 99 percent figure at the ten-year point.

III. DATA AND METHODOLOGY

A. DATA SETS

The data sets used for this analysis were obtained from the Officer Master File database maintained at the Defense Manpower Data Center, Monterey, California. The Officer Master File (OMF) has over 300 fields of longitudinal information on the careers of all officers in the Navy and Naval Reserve, and is indexed by Social Security Number. The fields of interest for this thesis were demographic data such as sex, race, marital status, education (level of education, schools attended), and subspecialty codes earned. Initially all Naval Officers serving between 1992 and 1998 were used to make six separate data sets for those officers who were on duty in each year. These six data sets were trimmed to include only officers in ranks Lieutenant through Captain to take into account the fact that a vast majority of Junior Officers (Ensigns and Lieutenants Junior Grade) may not be eligible to leave the service voluntarily due to initial service obligations. Once the data sets were reduced to only those eligible to leave the service voluntarily, the officers who left the Navy involuntarily were removed from the data sets by using the separation code from the OMF. Eliminating officers who left the Navy involuntarily was necessary because they were not relevant to a study of retention. Officers who served a full thirty years in uniform and retired from active duty were also removed. Since officers who attend NPS incur obligated service following their graduation, those officers who graduated from NPS within three years of the year of the data set were removed (e.g. for the 1997 data set, all officers who graduated from NPS in 1997, 1996, and 1995 were removed.) This final reduction of the data set was necessary

to counter any inflated significance graduate education may have been given by the the effect of officers who could not leave voluntarily.

Once all necessary removals were made each data set was split into two groups: those officers who remained on active duty through the year and those who chose to leave. The number of officers in each category compared to the number of records in the original data sets extracted from the OMF can be seen in Table 3.1.

	Officers in Original File	Data set Total	Officers who Stayed	Officers who Left
1992	70262	40605	37221	3384
1993	65373	36360	32045	4315
1994	60441	36857	32757	4100
1995	58019	35707	32437	2770
1996	57154	33604	30518	3086
1997	55648	34310	30721	3589

Table 3.1: Size of Data Sets from Officer Master File. Of the 55,648 officers in the Officer Master File for 1997, only 34,310 fit the criteria for the data set.

B. METHODOLOGY

1. Variable Definition

The model in this study regressed a dependent variable, based on retention, on a number of selected independent (explanatory) variables representing background and personal information. The independent variables were chosen from the background and education characteristics provided by the database. The dependent variable was a binary variable (QUIT), which assumed a value of 1 if the officer left the Navy during a specified year and 0 if the officer remained in the service throughout the whole year. Retention for a single year was defined by those officers who were in the Navy in the year of study and also in the Navy in the following year. For example, the 1997 QUIT variable was defined by those officers who were in the OMF in 1997 and also in the

OMF in 1998. Those officers who were in the 1997 file and not in the 1998 file were labeled with a 1 for the QUIT variable.

The independent variables were broken into two categories: (1) demographic variables and (2) professional/education variables. The demographic variables were SEX, RACE, MARRIED, and DEPS. The professional/educational variables were PAYGRADE, COMMUNITY, and EDUCATION. SEX, was assigned a value of 1 if the individual was male and 2 if the officer was female. RACE assumed a value of 1 for white officers, 2 for African-American officers, and 3 if the officer was of any other ethnic group. MARRIED assumed a value of 0 if the officer was single and 1 if he or she was married. DEPS assumed a value of 0 if the number of dependents was unknown, 1 for no dependents, 2 for one dependent, 3 for two dependents, 4 for three dependents, 5 for four dependents, 6 for five dependents, 7 for six dependents, and 8 for seven or more dependents. PAYGRADE was assigned one of four categorical values for the rank of the officer: 23 for O-3, 24 for O-4, 25 of O-5, and 26 if the officer was an O-6. The variable COMMUNITY was included to capture the service component of an officer and was assigned values as follows: 1 if the officer was a member of the Surface Warfare community, 2 if the officer was a member of the Submarine community, 3 if the officer was a member of the Aviation community, 4 if the officer was a member of the Restricted Line, 5 if the officer was a member of the Staff Corps, 6 if the officer was a Limited Duty Officer, 7 if the officer was a member of the Special Warfare community, or 8 if the officer did not fall in one of the previous categories. Finally, relating to the heart of this thesis, EDUCATION was assigned values of 0 for an officer with no college degree, 1 for an officer with a Bachelor's Degree, 2 if an officer received a Master's

Degree from NPS, 3 for other funded Master's Degree programs (graduate education that granted the officer a p-code), 4 for an officer who earned a Master's Degree at his or her own expense (no p-code earned), 5 if the officer received a funded Ph.D, and 6 if no funding was used and the officer possessed a Ph.D. Definitions for the dependent and independent variables can be found in tabular for in Appendix A. The distributions of observations by independent variables are included in Tables 3.2-3.8.

SEX	1992	1993	1994	1995	1996	1997
Male	88.2	87.9	87.4	86.8	86.4	86.1
Female	11.8	12.1	12.6	13.2	13.6	13.9

Table 3.2: Percentage Of Officers By Sex

RACE	1992	1993	1994	1995	1996	1997
Unknown	1.4	2.7	2.7	2.7	2.8	3.1
White	92.4	91.9	91.3	90.9	90.4	89.7
African-American	3.8	4.0	4.4	4.7	4.9	5.2
Other	2.4	1.4	1.6	1.7	1.9	2.0

Table 3.3: Percentage Of Officers By Race

MARRIED	1992	1993	1994	1995	1996	1997
Single	21.2	21.3	21.2	21.3	21.0	20.9
Married	78.8	78.7	78.8	78.7	79.0	79.1

Table 3.4: Percentage Of Officers By Marital Status

DEPS	1992	1993	1994	1995	1996	1997
Unknown	22.1	22.3	22.2	22.2	22.1	21.9
None	21.2	21.7	21.7	21.8	21.8	21.6
One	17.2	17.2	17.4	17.5	17.4	17.3
Two	24.9	24.5	24.5	24.3	24.3	24.7
Three	10.6	10.4	10.4	10.5	10.5	10.5
≥Four	4.0	3.9	3.8	3.7	3.9	4.0

Table 3.5: Percentage Of Officers By Number of Dependents

PAYGRADE	1992	1993	1994	1995	1996	1997
O-3	48.8	50.6	50.8	49.2	48.3	47.7
O-4	27.6	24.7	24.8	26.0	26.3	26.2
O-5	16.2	16.8	16.5	17.1	17.5	18.0
O-6	7.4	7.9	7.9	7.7	7.9	8.1

Table 3.6: Percentage Of Officers By Pay Grade

COMMUNITY	1992	1993	1994	1995	1996	1997
Other	4.5	4.2	3.6	0.2	1.8	0.1
Surface	13.9	13.4	12.7	12.5	12.4	12.3
Submarine	6.2	6.5	6.5	6.5	6.4	6.3
Special Warfare	1.4	1.5	1.6	1.5	1.5	1.5
Aviation	25.3	25.3	25.2	25.1	25.2	24.8
Restricted Line	8.7	8.7	9.2	12.6	11.1	12.8
Staff Corps	33.6	34.1	34.6	35.0	35.2	35.8
LDO	6.4	6.3	6.6	6.6	6.4	6.4

Table 3.7: Percentage Of Officers By Community

	1992	1993	1994	1995	1996	1997
No College Degree	3.7	3.6	3.1	2.9	2.7	2.9
Bachelor's Degree	55.1	58.1	53.4	54.1	54.8	51.7
NPS Master's Degree	8.7	9.0	8.8	8.9	9.8	9.5
Other Funded Master's Degree	9.2	9.4	8.9	8.7	9.4	9.3
Non-funded Master's Degree	22.4	19.0	24.9	24.3	22.3	25.4
Funded Ph.D	0.7	0.8	0.8	0.7	0.6	0.7
Non-funded Ph.D	0.2	0.1	0.1	0.4	0.4	0.5

Table 3.8: Percentage Of Officers By Education Level

2. Logit Regression

Logit regression is a predictive model for a binary dependent variable based on a linear combination of independent variables. The variable QUIT is the dependent variable and the goal is to estimate the probability that an officer with certain background information will leave the service. The logit is the natural logarithm of the odds ratio:

$$L_i = \log_e\left[\frac{p_i}{(1-p_i)}\right]$$

where p_i is the probability that the i^{th} officer quits. Logit regression is used to represent models of the form:

$$L_i = \beta_0 + \beta_1 X_{i,1} + \beta_2 X_{i,2} + \ldots + \beta_{K-1} X_{i,K-1}$$

If the logit (L_i) is a linear function of the vector of dependent variables, X_i, then the probability (p) is a nonlinear function with a loose S-shape. Predicted probabilities approach, but never reach, the limits of 0 and 1. This means that logit regression presents a more accurate model for probabilities than standard linear regression. (Hamilton, 1992)

The computer statistical package S-Plus version 4.5 (MathSoft Inc., 1998) was used to model the OMF data using logit regression. The initial models included all of the potential predictor variables available from the data sets. Predictor variables were removed from the model if the *t*-value in the model output corresponding to the variable was insignificant at the α=0.05 test level. After the removal of a variable the model was run again to determine if any other variables had insignificant *t*-values. If so, the process was repeated until all *t*-values were significant. Additionally, the `step` function of S-Plus performed a stepwise model selection. This is accomplished by generating a series of models sequentially, where each model differs from its neighbors by a single term.

3. Classification tree modeling of OMF data

Using S-Plus, a classification tree was also constructed from the same data sets that were used for logit modeling. Due to the relatively large size of the data sets and the small proportion of the population with the response variable equal to 1 (roughly ten percent), the classification tree estimated from the data was identical to the "naive" model in which all officers are predicted to remain in the Navy for a given year. Using the classification tree, cross-validating and minimizing the deviance at the terminal nodes, the explanatory variables were unable to detect even one grouping of officers of which more than fifty percent left the Navy during a specific year. Thus, the misclassification rate was the same as if one assumed no officers left the Navy in the year of interest. Figure 3.1 displays the output from one year for a tree classification of the retention data. Since the classification tree did not give any additional insight into the retention issue, no further attempt was made to analyze the remaining data sets with a classification tree.

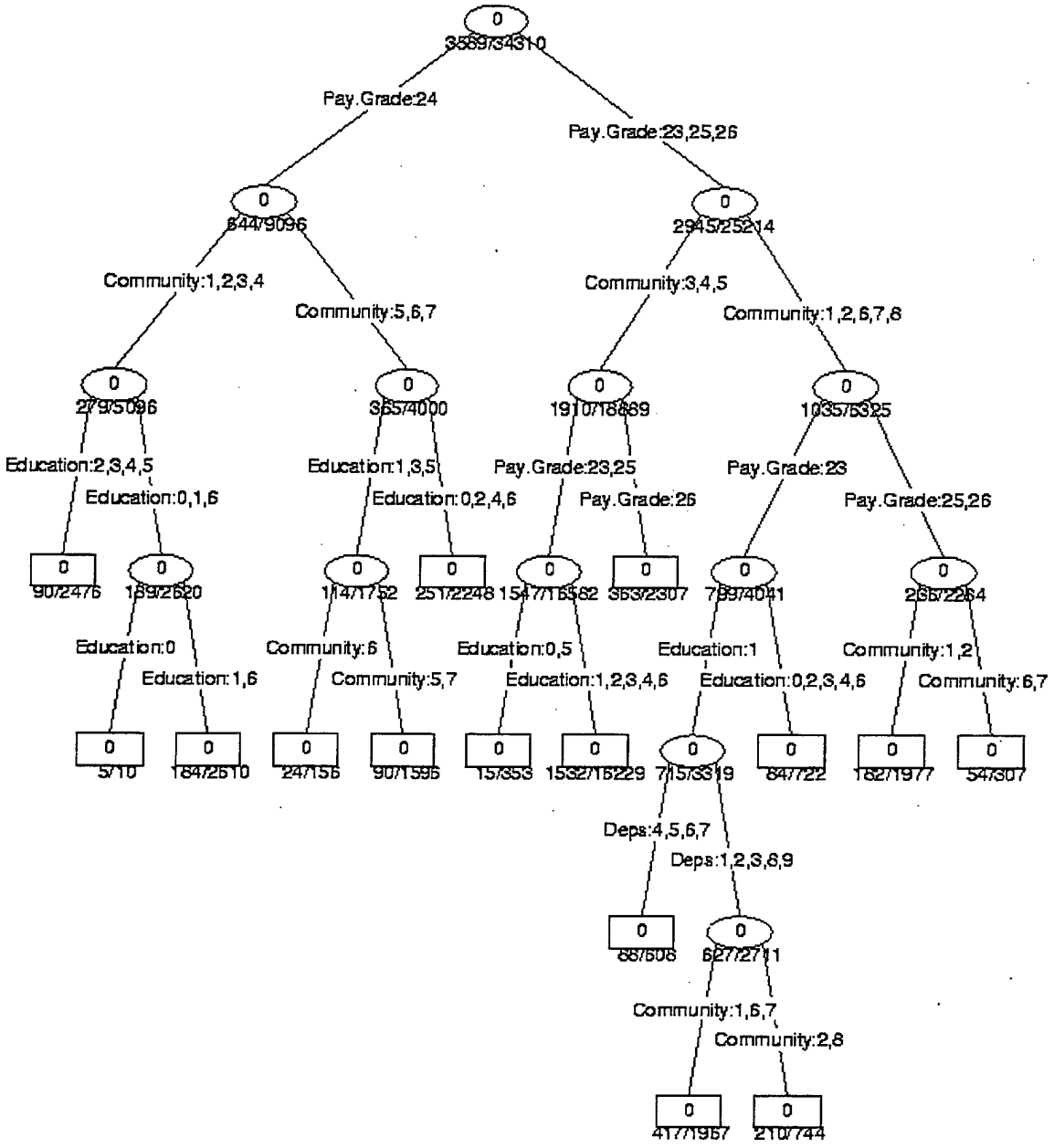

Figure 3.1: Classification Tree Graph for 1997 Data Set. The zeros at every terminal node indicate the model predicts that no officers will leave in this instance. The number below each node is the ratio of misclassified observations. For example, following the leftmost branch of the tree: An officer who is a Lieutenant Commander; in the Surface Warfare, Submarine, Aviation, or Restricted Line community; and has an NPS Master's Degree, a Master's Degree through a different funded program, a non-funded Master's Degree, or a funded Ph.D is predicted to stay in the Navy with a misclassification rate of 90/2476

IV. RESULTS

Separate models were developed for each of the six data sets. The predictor variables that were statistically insignificant were removed. In each year examined, except for the 1994 data set, the EDUCATION variable was found to be significant at the α=0.05 level. The resulting models were similar to the model obtained from the 1997 data set, which was the following:

$L_i = \beta_0 + \beta_1$ PAYGRADE $+\beta_2$ EDUCATION $+ \beta_3$ COMMUNITY $+ \beta_4$ DEPS $+\beta_5$ RACE.

Table 4.1 summarizes the logit model for the 1997 data set. The remaining five summaries are included in Appendix B. The "baseline" officer for the logistic regression model was a Surface Warfare Lieutenant with no college degree, an unknown number of dependents, and race unknown (PAYGRADE is set equal to 23, EDUCATION is set equal to 0, COMMUNITY is set equal to 1, DEPS and RACE are set equal to 0.) Using the L_i equation listed above on a sample officer leads to his or her probability of leaving the Navy. For example, using the estimated model parameters from Table 4.1, a white, Surface Warfare Lieutenant with a Master's Degree from NPS and no dependents yields a logit equation of $L_i = -1.9 + 0.019 + (0) + (-0.051) + 0.054 = -1.8782$. Therefore, the estimated probability that this sample officer left in 1997 is $[1+\exp(1.8782)]^{-1} = 0.133$ or 13.3 percent.

When the education parameter was isolated, it did not show a tremendous effect on an officer's propensity to leave the Navy. From the logit model, the baseline officer had an estimated attrition probability of 13.0 percent. The addition of only the NPS Master's Degree raised the estimated probability of separating from the Navy to 13.2 percent. A 0.2 percent decrease in the retention probability appears not to be consistent

Variable	Level	Value	Std. Error	t-value
(Intercept)		-1.900	0.170	-11.00
Pay Grade	Lieutenant Commander	-0.460	0.052	-8.90
	Commander	-0.018	0.056	-0.32
	Captain	0.440	0.066	6.60
Education	Bachelor's Degree	0.260	0.130	2.10
	NPS Master's Degree	0.019	0.150	0.13
	Other Funded Master's	0.110	0.140	0.79
	Non-funded Master's	0.075	0.130	0.56
	Funded Ph.D	-0.590	0.320	-1.90
	Non-funded Ph.D	0.310	0.270	1.20
Community	Submarine	0.025	0.075	0.34
	Aviation	-0.560	0.059	-9.50
	Restricted Line	-0.350	0.068	-5.20
	Staff Corps	-0.320	0.057	-5.70
	Limited Duty Officer	0.310	0.110	2.70
	Special Warfare	-0.100	0.130	-0.76
	Other	1.200	0.450	2.70
Dependents	Member Only(None)	-0.051	0.052	-0.97
	One	-0.043	0.057	-0.75
	Two	-0.190	0.055	-3.40
	Three	-0.160	0.071	-2.30
	Four	-0.270	0.120	-2.30
	Five	-0.032	0.230	-0.14
	Six	0.410	0.370	1.10
	≥Seven	0.750	0.440	1.70
Race	White	0.054	0.110	0.51
	Black	-0.370	0.140	-2.60
	Other	0.150	0.160	0.96

Table 4.1: Logistic Model Summary (1997). In this case, the coefficient to be used in the logit equation for an NPS Master's Degree is 0.019.

with the 38 percent increase in retention found by Jordan (1991) or the 61 percent differential in retention between Bachelor's degree holders (38 percent retained to the ten-year point) and NPS Master's degree holders (96 percent retained to the ten-year point) found by Fuchs (1996). The difference is largely explained by the differences in the construction of the data sets used by this thesis and previous studies. Jordan and Fuchs modeled retention to the Lieutenant Commander Screening Board, an event that takes place at about the tenth year in an officer's career. Officers who complete a

Degree at NPS are almost certain to remain in the Navy for at least ten years for reasons cited earlier. The present study attempted to model retention on a year-to-year basis by asking the question: Of those officers who were eligible to quit each year, how many actually did and what do we know about them?

The proportion of officers who leave the Navy each year is quite small compared to the proportion who stay in each year. There is a turnover rate of only approximately 10 percent each year. In the case of 1997 there were 34310 officers in the data set. Of those officers, only 3589 left the Navy, or 10.46 percent of the officers in the data set left in 1997. If those who leave are broken down into categories it may be possible to see trends in the retention rate. Table 4.2 shows the proportion of officers who left each year broken down by education level. In each year the proportion of officers who left and possessed a Master's Degree from NPS was near the lowest of the seven categories. In fact, the only education category with a lower proportion of officers leaving the Navy is those officers who receive a funded Ph.D. The proportion of officers who receive a funded Master's Degree to those who receive a funded Ph.D is on the order of a factor of fifteen (3261:227 in 1997). The limited size of the Ph.D category could be the difference between the two with regard to the proportion who leave each year.

Multiple comparison tests were run on each data set focusing on the education level. Aside from the 1997 data set, none of the levels of EDUCATION varied significantly from one another at a 95 percent confidence interval. In the 1997 data set an officer with a Bachelor's Degree differed significantly from an officer with a Master's Degree from NPS. In other words, the confidence interval for the difference of the means did not contain zero. However, since the other five data sets did not show this difference

it can be assumed that there is no statistical difference between the different levels of the EDUCATION variable.

EDUCATION	1992	1993	1994	1995	1996	1997
No College	10.9	11.5	11.1	10.8	12.1	12.0
Bachelor's Degree	8.8	11.9	10.6	8.1	9.4	11.3
NPS Master's Degree	8.0	11.1	9.6	5.7	7.3	8.8
Other Funded Master's Degree	8.6	11.8	10.5	6.1	7.8	9.9
Non-funded Master's Degree	9.2	12.0	10.1	8.0	9.6	9.4
Funded Ph.D	6.1	10.2	8.4	7.7	6.9	5.2
Non-funded Ph.D	9.3	22.6	11.7	9.4	14.6	11.4

Table 4.2: Proportion of Officers Leaving the Navy by Education Level. Officers with NPS Master's Degrees consistently have one of the lowest proportions of officers leaving the Navy. For each year in the study only officers with funded Ph.D's left the Navy in smaller proportions than officers with Master's Degrees from NPS.

V. DISCUSSION

A. SUMMARY

The findings of previous research support the contention that a Naval Officer with graduate education, specifically fully funded graduate education, is promoted at a statistically higher rate and also remains in the Navy to the ten-year mark at a statistically higher rate. The career progression of officers who receive funded graduate education differs from officers who do not. Officers who receive graduate education do not have the same opportunity to leave the Navy early on in their careers that officers who only possess Bachelor's Degrees have. This issue is not considered in the analysis in Jordan (1991) and Fuchs (1996) concerning retention to the Lieutenant Commander Screening Board. Both studies concluded that funded graduate education had significant positive impact on retention of Naval officers. In Jordan (1991) further analysis was conducted on whether funded graduate education had an impact on retention to the Commander screening board for General Unrestricted Line Officers. However, due to a small sample size and "lack of sufficient variation in the LEAVE versus STAY behavior (i.e., only 47 of 790, 6%, actually left the Navy voluntarily)" (Jordan, 1991, p.59) no conclusions were made as to the impact of graduate education for these more senior officers. In fact, even in Jordan's Commander promotion models the Postgraduate School predictor was found to be statistically insignificant. Since the Commander Selection Board is held later in an officer's career, usually around the 15-year point, this may be a more accurate portrayal of the impact of graduate education on retention.

The models used in this thesis remove the service obligation for officers who receive funded graduate education by eliminating officers who could not leave

voluntarily. The data sets represent the pool of officers that are eligible to make a decision to stay in the Navy or leave. Since the population of the data sets is more representative of the officers that actually face the choice to leave the Navy, the model is more likely to capture the true effect of graduate education on retention.

B. CONCLUSIONS

Officer retention is an issue that is currently extremely important to the Navy. Graduate education is a significant factor in retaining officers through a certain point in his or her career but the bulk of that significance comes from obligated service incurred by an officer in exchange for the graduate education. Once the target population is identified, the effect of graduate education on one-year retention is severely diminished. That is not to say that there are no benefits to the Navy in providing these officers funded graduate education. The four previous Master's theses (Jordan, 1991; Talaga, 1994; Buterbaugh, 1995; Fuchs, 1996) all offer insight into the positive effects that graduate education has on the overall quality of the officer corps. The issue of promotion rates and probabilities of gaining command are separate from of the retention issue and are not subject to the same constraints regarding incurred obligation.

It is extremely difficult to model human behavior for a single individual. It is entirely possible that officers who apply for and receive funded graduate education have different career aspirations than officers who do not for reasons that are not explained by demographic data. However, it is possible to see trends from a large number of individuals that form a group. A funded graduate education does not appear to have a substantial effect on retention past obligated service lengths (a 0.2 percent decrease from the 1997 data) but it is true that the proportion of officers with funded Master's Degrees

leaving the Navy is consistently lower than that of those who earn a Master's Degree on their own or have only a Bachelor's Degree.

APPENDIX A. MODEL VARIABLE DESCRIPTIONS

DEPENDENT VARAIBLE	DESCRIPTION
QUIT	= 1 if officer left the Navy ion year = 0 if remained in service
DEMOGRAPHICS	
SEX	= 1 if male = 2 if female
RACE	= 0 if unknown = 1 if Caucasian = 2 if African-American = 3 if other ethnic group
MARRIED	= 0 if unmarried = 1 if married
DEPS	= 0 if unknown = 1 member only and 0 dependents = 2 member and 1 additional dependent = 3 member and 2 additional dependents = 4 member and 3 additional dependents = 5 member and 4 additional dependents = 6 member and 5 additional dependents = 7 member and 6 additional dependents = 8 member and additional 7-15 dependents
PROFESSIONAL/EDUCATION	
COMMUNITY	= 1 if Surface Warfare Officer = 2 if Submariner = 3 if Aviator = 4 if Restricted Line Officer = 5 if Staff Corps Officer = 6 if Limited Duty Officer = 7 if Special Warfare Officer = 8 if other
PAYGRADE	= 23 Lieutenant (O-3) = 24 Lieutenant Commander (O-4) = 25 Commander (O-5) = 26 Captain (O-6)
EDUCATION	= 0 no college degree = 1 Bachelor's Degree = 2 Master's Degree from NPS = 3 Other funded Master's Degree = 4 Non-funded Master's Degree = 5 Funded Ph.D = 6 Non-funded Ph.D

APPENDIX B. REGRESSION SUMMARIES FOR 1992-1996

Model for 1992 data set:

$$L_i = \beta_0 + \beta_1 \text{PAYGRADE} + \beta_2 \text{EDUCATION} + \beta_3 \text{COMMUNITY} + \beta_4 \text{MARRIED} + \beta_5 \text{RACE}$$

Results:

Coefficients:			
	Value	Std. Error	t-value
(Intercept)	-4.4	8.2	-0.54
Lieutenant Commander	-0.16	0.046	-3.6
Commander	-0.13	0.056	-2.3
Captain	0.16	0.068	2.3
Bachelor's Degree	-0.21	0.12	-1.7
NPS Master's Degree	-0.14	0.14	-1.0
Other Funded Master's Degree	-0.086	0.13	-0.62
Non-funded Master's Degree	-0.047	0.13	-0.37
Funded Ph.D	-0.47	0.27	-1.73
Non-funded Ph.D	-0.065	0.41	-0.15
Submarine	-0.11	0.081	-1.4
Aviation	-0.37	0.058	-6.4
Restricted Line	-0.39	0.079	-5.0
Staff Corps	-0.22	0.059	-3.7
Limited Duty Officer	0.021	0.12	0.17
Special Warfare	-0.55	0.17	-3.2
Other Community	-0.11	0.092	-1.3
Single	3.2	8.2	0.39
Married	3.0	8.2	0.38
White	-0.66	0.12	-5.1
African-American	-0.99	0.16	-6.1
Other Race	-1.1	0.18	-6.0

Table B.1: Logit Model Results for 1992 Data

Model for 1993 data set:

$$L_i = \beta_0 + \beta_1 \text{PAYGRADE} + \beta_2 \text{EDUCATION} + \beta_3 \text{COMMUNITY} + \beta_4 \text{MARRIED} + \beta_5 \text{RACE}$$

Results:

Coefficients:			
	Value	Std. Error	t-value
(Intercept)	-1.5	0.17	-9.1
Lieutenant Commander	-0.34	0.045	-7.6
Commander	-0.068	0.050	-1.4
Captain	0.11	0.062	1.8
Bachelor's Degree	0.096	0.13	0.74
NPS Master's Degree	0.10	0.14	0.70
Other Funded Master's Degree	0.24	0.14	1.7
Non-funded Master's Degree	0.31	0.13	2.3
Funded Ph.D	0.12	0.23	0.50
Non-funded Ph.D	0.71	0.44	1.6
Submarine	0.022	0.067	0.33
Aviation	-0.34	0.051	-6.6
Restricted Line	-0.56	0.073	-7.6
Staff Corps	-0.47	0.055	-8.6
Limited Duty Officer	-0.079	0.13	-0.63
Special Warfare	-0.69	0.15	-4.5
Other Community	-0.20	0.086	-2.3
Married	-0.078	0.040	-1.9
White	-0.18	0.097	-1.9
African-American	-0.62	0.14	-4.5
Other Race	-0.29	0.17	-1.7

Table B.2: Logit Model Results for 1993 Data

Model for 1994 data set:

$$L_i = \beta_0 + \beta_1 \text{PAYGRADE} + \beta_2 \text{COMMUNITY} + \beta_3 \text{MARRIED} + \beta_4 \text{DEPS} + \beta_5 \text{RACE}$$

Results:

Coefficients:			
	Value	Std. Error	t-value
(Intercept)	-2.0	0.13	-16.0
Lieutenant Commander	-0.64	0.050	-13.0
Commander	0.21	0.044	4.7
Captain	0.6	0.051	12.0
Submarine	0.12	0.068	1.8
Aviation	-0.17	0.052	-3.3
Restricted Line	-0.21	0.063	-3.4
Staff Corps	-0.33	0.049	-6.7
Limited Duty Officer	0.057	0.098	0.58
Special Warfare	-0.24	0.14	-1.7
Other Community	-3.2	0.30	-10.0
Married	-0.12	0.076	-1.6
One Dependent	0.0081	0.080	0.10
Two Dependents	0.028	0.083	0.34
Three Dependents	-0.075	0.083	-0.89
Four Dependents	-0.094	0.092	-1.0
Five Dependents	0.25	0.11	2.2
Six Dependents	0.13	0.21	0.64
≥ Seven Dependents	0.51	0.32	1.6
White	0.16	0.12	1.4
African-American	-0.32	0.15	-2.1
Other Race	0.23	0.18	1.3

Table B.3: Logit Model Results for 1994 Data

Model for 1995 data set:

$$L_i = \beta_0 + \beta_1 \text{PAYGRADE} + \beta_2 \text{EDUCATION} + \beta_3 \text{COMMUNITY} + \beta_4 \text{MARRIED} + \beta_5 \text{DEPS} + \beta_6 \text{RACE}$$

Results:

Coefficients:			
	Value	Std. Error	t value
(Intercept)	-2.400	0.200	-12.00
Lieutenant Commander	-0.540	0.058	-9.40
Commander	-0.190	0.063	-3.00
Captain	0.250	0.074	3.40
Bachelor's Degree	0.076	0.140	0.55
NPS Master's Degree	-0.190	0.160	-1.20
Other Funded Master's Degree	-0.170	0.160	-1.00
Non-funded Master's Degree	0.120	0.140	0.80
Funded Ph.D	0.041	0.280	0.15
Non-funded Ph.D	0.270	0.340	0.81
Submarine	0.260	0.083	3.10
Aviation	-0.390	0.068	-5.80
Restricted Line	-0.160	0.080	-2.00
Staff Corps	-0.110	0.067	-1.60
Limited Duty Officer	0.510	0.130	4.00
Special Warfare	-0.640	0.200	-3.20
Other Community	-0.800	0.720	-1.10
Married	-0.170	0.087	-2.00
One Dependent	0.180	0.091	2.00
Two Dependents	0.120	0.096	1.20
Three Dependents	0.036	0.097	0.37
Four Dependents	-0.078	0.110	-0.70
Five Dependents	0.140	0.150	0.94
Six Dependents	0.430	0.240	1.80
≥ Seven Dependents	-0.340	0.600	-0.57
White	0.190	0.130	1.50
African-American	-0.230	0.170	-1.40
Other Race	0.180	0.200	0.94

Table B.4: Logit Model Results for 1995 Data

Model for 1996 data set:

$$L_i = \beta_0 + \beta_1 \text{PAYGRADE} + \beta_2 \text{EDUCATION} + \beta_3 \text{COMMUNITY} + \beta_4 \text{MARRIED} + \beta_5 \text{RACE}$$

Results:

Coefficients:			
	Value	Std. Error	t-value
(Intercept)	-2.000	0.190	-10.00
Lieutenant Commander	-0.660	0.056	-12.00
Commander	-0.150	0.058	-2.60
Captain	0.270	0.069	3.90
Bachelor's Degree	0.032	0.140	0.22
NPS Master's Degree	-0.055	0.160	-0.34
Other Funded Master's Degree	-0.140	0.160	-0.90
Non-funded Master's Degree	0.084	0.150	0.56
Funded Ph.D	-0.320	0.310	-1.00
Non-funded Ph.D	0.530	0.290	1.80
Submarine	0.067	0.082	0.82
Aviation	-0.480	0.064	-7.40
Restricted Line	-0.065	0.074	-0.87
Staff Corps	-0.120	0.063	-1.90
Limited Duty Officer	0.390	0.130	2.90
Special Warfare	-0.420	0.170	-2.50
Other Community	-2.400	0.370	-6.60
Married	-0.160	0.046	-3.40
White	0.110	0.120	0.94
African-American	-0.440	0.160	-2.80
Other Race	0.095	0.180	0.53

Table B.5: Logit Model Results for 1996 Data

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