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NAVAL POSTGRADUATE SCHOOL
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THESIS

DEMAND AND SUPPLY
OF HIGH QUALITY SAILORS

by

Wayne R. Van Doren

December 1981

Thesis Advisor: George W. Thomas

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Demand and Supply of High Quality Sailors

by

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ABSTRACT

This study was conducted to determine empirically the demand and supply of high quality sailors in the U.S. Navy. The Navy's demand for high quality sailors is presented in two dimensions; the entry level demand and utilization demand. Three forms of enlistment supply models are developed for high school diploma graduate enlistments and for high quality enlistments using ordinary least squares regression methodology. The demand and supply results are then applied to an increasing size Navy scenario. A two-tier pay system is implied from the application of the supply models since the high quality enlistees are less responsive to pay changes than are high school diploma graduate enlistees.

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I. INTRODUCTION AND LITERATURE REVIEW

A. INTRODUCTION

Since the inception of the All-Volunteer Force, the military services and military manpower analysts have been increasingly concerned with the quantity of enlistees entering the various services. Additionally, with an ever-increasing reliance upon high technology equipment, the military services have begun to feel the need for increasing qualities in enlistees (Fialka).

This study examines two groups of Navy non-prior service (NPS) males. The first group consists of high school diploma graduates of all mental categories. The second group of interest is high quality enlistments, who are defined to be high school diploma graduate enlistees scoring in Mental Categories I and II on the Armed Forces Qualification Test (AFQT). This thesis attempts to determine empirically the demand and supply of these two quality levels of U.S. Navy male non-prior service (NPS) enlistments and explores alternative compensation methods for obtaining a required number of high quality enlistees.

The next section of this chapter will present a brief synopsis of work indicating why the Navy is interested in high quality enlistees. This chapter concludes with a review of the major enlistment supply models. Chapter II

will present the methodology to be followed in performing the analysis of demand and supply of high quality sailors. The results from the demand and supply data analysis will be presented in Chapters III and IV. An application of the analysis to evaluate alternative compensation systems for enlisting a desired number of high quality sailors will be presented in Chapter V. The thesis concludes with a summary and discussion of policy implications in Chapter VI.

B. INTEREST IN HIGH QUALITY SAILORS

In recent years there have been efforts to explain the various parameters of enlistee performance in the Navy using enlistee quality. These studies have often defined enlistee quality in terms of years of education completed or Armed Forces Qualification Test (AFQT) mental categories. The focus of these studies has largely been upon two factors. The first factor is performance as measured by pay grade attainment or by equipment readiness. The second factor is the propensity of an enlistee to attrite from the Navy.

The Technical Cooperation Program study "Attrition in the Armed Services of Canada, the UK, and the U.S." recently examined the quality of personnel in the military services of Canada, the United Kingdom, and the United States. This study found that in the U.S. Navy "With the exception of Mental Category IV, the relationship between mental category and attrition rate is monotonically increasing (Sinaiko and Scheflen)." The percentage of total attrition at 36 months

of service by mental category for U.S. Navy NPS male accessions is presented in Table 1.

TABLE 1

% ATTRITION AT 36 MONTHS OF SERVICE BY MENTAL CATEGORY

(1974-75 U.S. Navy Cohort)

Mental Category	% Attrition
I	19.8
II	26.1
IIIA	36.9
IIIB	49.1
IV	39.4

SOURCE: Sinaiko and Scheflen

Further, the study presents data on the 1974-75 Navy NPS male cohort attrition rates with respect to education level. Here, the high school diploma graduates (HSDG) displayed a lower attrition rate than non-high school diploma graduates during the first 36 months of service. These data are presented in Table 2.

TABLE 2

% ATTRITION DURING THE FIRST 36 MONTHS OF SERVICE BY EDUCATION LEVEL

(1974-75 U.S. Navy Cohort)

LOS	HSDG	Non-HSDG
0-6 months	8.8	22.4
0-12 months	12.9	30.5
0-36 months	27.3	57.0

SOURCE: Sinaiko and Scheflen

The Navy Recruiting Command has been using a model developed by Lockman at the Center for Naval Analyses called "Success Chances of Recruits Entering the Navy (SCREEN)." The SCREEN model is the result of regression analysis on a number of recruit quality factors. Among the factors analyzed, membership in Mental Category I or II or possession of a high school diploma indicates a much higher likelihood of completing two years of service in the Navy (SCREEN).

A study by Horowitz and Sherman from the Center for Naval Analyses investigates the impact of quality of personnel aboard a sample of cruisers, frigates, and destroyers. In it, the quality of personnel is matched against the material condition of the ship on which the personnel are stationed. Horowitz and Sherman conclude that "high quality personnel are, in general, more valuable on ships with the most complex equipment (Horowitz and Sherman)."

In "A Study of Relationships Between Educational Credentials and Military Performance Criteria" by Elster and Flyer, pay grade attainment is investigated as a function of education and mental category. Assuming that pay grade attainment is a suitable proxy for job performance, it can be seen from Table 3 that high quality sailors are better performers in the Navy. From the Calendar Year 1977 cohort, 62 percent of the high quality accessions advanced to petty officer (pay grade E-4 or E-5). This is a 40 percent greater rate of petty officer pay grade attainment than that for total

non-prior service (NPS) male high school diploma graduates (HSDG) and a 63 percent greater petty officer pay grade attainment than total NPS male accessions in the CY 1977 cohort.

TABLE 3

U.S. NAVY PAY GRADE DISTRIBUTIONS FOR CY77
NPS MALE ACCESSIONS ON ACTIVE DUTY 30 SEP 79

Pay Grade	HSDG	HQ	TOTAL
E-5	5	9	3
E-4	39	53	35
E-3	45	32	46
E-2	9	5	12
E-1	2	1	4
Total	100	100	100
Mean Pay Grade Achieved	3.3	3.6	3.2

SOURCE: Elster and Flyer

From these enlistee quality studies, two operall conclusions can be made. First, high school diploma graduate enlistees are better than non-high school diploma graduate enlistees in terms of their lower propensity to attrite from the Navy and their better job performance. Second, high quality enlistees are better than high school diploma graduate enlistees in general in terms of their lower propensity to attrite from the Navy and their higher job performance.

C. SUPPLY LITERATURE REVIEW

This section presents a review of the literature on enlistment supply models. While it is not exhaustive in nature, it attempts to highlight the major enlistment supply models. A very good comparison of the three major enlistment supply models may be found in, "Department of Defense and Navy Personnel Supply Models: Report of a Workshop."

1. The Rand Model

The model commonly referred to as the Rand model is a result of Fernandez' work in, "Forecasting Enlisted Supply: Projections for 1979-1990." In his study, Fernandez develops three enlistment supply models for Navy non-prior service (NPS) male high school diploma graduates (HSDG). One model was developed for Mental Categories I and II, a second model was developed for Mental Category IIIA, and the third model was developed for Mental Category IIIB.

The dependent variable in each model is the Navy NPS male HSDG enlistment rate for the particular mental categories analyze. As explanatory variables Fernandez uses relative pay, the number of production recruiters, and a youth unemployment rate. The relative pay variable was defined as the average first year regular military compensation for enlistees with less than two years of service divided by the average weekly earnings in the total private economy. Unemployment was a lagged seasonally adjusted unemployment rate for 16-19 year old males.

Quarterly observations on all variables from July 1970 through September 1978 were used in estimating the models. The data were fitted to a linear enlistment supply model. The coefficients from the model estimations are presented in Table 4. From Fernandez' study, the result of particular interest is the imputed relative pay elasticity of .63 for non-prior service male high school diploma graduates in mental categories I and II (Fernandez). This will be used for comparison later in the supply determination chapter.

TABLE 4

FERNANDEZ ENLISTMENT SUPPLY MODEL RESULTS SUMMARY

(Data are regression coefficients and R^2)

	Mental Category		
Variable	I & II	IIIA	IIIB
Recruiters		.1259	.1235
Relative Pay	14.61	-.30	4.52
Unemployment	49.56	29.12	27.83
R	.880	.919	.914

SOURCE: Fernandez

2. The Duke Model

This model was developed by Morey at Duke University and was first presented in "Budget Allocation and Enlistment Prediction Models for the Navy's Recruiting Command: Testing and Validation." Morey develops two separate enlistment supply models, one for all Navy non-prior service (NPS) male

high school diploma graduates (HSDG) and a second enlistment supply model for Navy NPS male HSDG's in Mental Categories I-IIIA.

The dependent variable used was the number of Navy enlistments for each respective group. Explanatory variables included number of Navy recruiters, several advertising variables measuring the impact of the various forms of advertising, percent black, percent urban/rural, unemployment rate, and a ratio of regular military compensation to average first year civilian earnings. Monthly data on the variables was used from January 1976 through September 1979 measured in the 43 Navy recruiting districts, and the data were fitted to a multiplicative model (Morey).

3. Center for Naval Analyses (CNA) Model

The CNA model was developed by Goldberg and presented in "Recruiters, Advertising, and Navy Enlistments." In this study, Goldberg estimates three enlistment supply models, one for all non-prior service (NPS) male high school diploma graduates (HSDG), a second for NPS male HSDG's in Mental Categories I-IIIA, and a third model for NPS male HSDG's in Mental Categories I and II.

Goldberg's basic model form is multiplicative with NPS male HSDG contracts per population as the dependent variable for each of the respective groups of mental categories. As explanatory variables, Goldberg uses relative

pay, unemployment, CETA expenditures per population[1], a G.I. Bill dummy variable, recruiters per population for each service, 17-21 year old male population, and the percentage of black in the population. Relative pay was defined as the average full-time earnings of 18 year old civilian males divided by first year's regular military compensation. The unemployment rate used was that for all civilians. CETA expenditures per population were represented by a youth programs variable and a countercyclical programs variable.

Data analyzed by Goldberg were annual data on the 43 Navy recruiting districts from October 1975 through September 1980. The results of Goldberg's analysis are presented in Table 5. From Table 5, at the .01 confidence level the variables that are consistently significant in each of the models are: relative pay, unemployment, population, Navy recruiters, and Air Force recruiters. This result is consistent with the other models presented in this chapter. The models form the basis of the methodology to be presented in Chapter II.

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[1]Per population refers to the 17-21 year old male population in the recruiting district.

TABLE 5

GOLDBERG'S NPS MALE HSDG SUPPLY MODELS RESULTS SUMMARY

(Data are regression coefficients and R^2)

	Mental Categories		
Variable	ALL**	I-IIIA**	I-II**
Constant	1.270	1.555	1.308
Relative Pay	-0.915**	-0.966**	-0.949**
Unemployment	0.316**	0.258**	0.248**
Population	0.142**	0.195**	0.225**
Navy Recruiters	0.437**	0.466**	0.523**
Air Force Recruiters	0.462**	0.581**	0.573**
Army Recruiters	0.285**	0.224	0.243
Marine Recruiters	-0.093**	0.024	0.073
Youth Programs	-0.042	-0.138	-0.184*
Countercyclical Programs	-0.085**	-0.085*	-0.090*
% Black	0.007**	0.000	-0.002
G.I. Bill Dummy	-0.004	-0.110**	-0.099*
R	.68	.72	.72

* Significant at the .05 level
** Significant at the .01 level

SOURCE: Goldberg, 1981

II. METHODOLOGY

In this chapter the method of determining the demand and supply of high quality sailors will be presented. High quality sailors are defined as those sailors who are in Mental Category I or Mental Category II and are high school degree graduates. Mental categories are defined in accordance with Table 6 as a result of the enlistees percentile score on the Armed Forces Qualification Test (Cooper).

TABLE 6

MENTAL CATEGORIES

Percentile Score	Mental Category
01-09	V
10-15	IV C
16-20	IV B
21-30	IV A
31-49	III B
50-64	III A
65-92	II
93-99	I

SOURCE: Cooper

In addition, this chapter will present two alternative wage policies for acquiring a required number of high quality sailors and a methodology for an economic comparison of the alternative wage policies.

A. DEMAND DETERMINATION

The determination of the U.S. Navy's historical demand for high quality sailors is made up of two components, stated policy and past practice. While policy and practice should ideally be the same, inspection of both policy and practice is required to fully understand the demand for high quality sailors. Two dimensions of demand will be examined; entry level and utilization.

1. Entry Level

One dimension of demand can be inferred by examining Navy policy statements and the proportion of high quality sailors entering the Navy. The U.S. Navy stated policy toward enlistment of high quality sailors will be extracted from the Manpower Requirements Reports for the fiscal years 1976 to 1980 inclusive (MRR FY76-FY80).

The past practice component of entry level demand will be measured by actual accession data. Accession data for the period from October 1975 through September 1980 will be obtained from the Defense Manpower Data Center. The data will consist of information on all individuals who signed enlistment contracts for the Navy in each of the fiscal years 1976 through 1980 inclusive. Data will include information on the education, mental category, race, and sex of these accessions. These data will be utilized to examine the practice of the Navy towards recruiting high quality sailors in the recent past.

2. Utilization

The second dimension of demand with which we are concerned is the utilization of high quality sailors. This will entail an examination of the distribution of high quality sailors across occupational fields. Data extracted from the Enlisted Active Duty Military Master and Loss and Edit file maintained at the Defense Manpower Data Center in Monterey, California, will be used to examine the past practice of the U.S. Navy in the utilization of high quality sailors. The data will consist of an occupational snapshot of Navy personnel on 1 October of each year from 1975 through 1980, inclusive. For each Navy occupational rating, the basic data will array personnel by length of service, mental category, highest year of education, and race.

Some occupational data will be aggregated to facilitate the analysis. The apprenticeship ratings will be grouped by apprenticeship field in accordance with Table 7.

Some of the Navy ratings have very few personnel; by examining only high quality sailors, the number of sailors in a given rating may be quite small. This necessitates grouping ratings to increase sample size while maintaining homogeneity of cells. A hybridization of the Navy Enlisted Classification System will be selected to accomplish this aggregation and is presented in Tables 8 and 9 (NEOCS). The hybridization entails a separation of those ratings which have been identified as having a significant percentage of six-year enlistees (Recruiting Manual).

TABLE 7

U.S. NAVY APPRENTICESHIP RATING GROUPING

Rating Abbreviation	Rating Name	Field
AR	Airman Recruit	
AA	Airman Apprentice	Air
AN	Airman	
CA	Constructionman Recruit	
CR	Constructionman Apprentice	Construction
CN	Constructionman	
DR	Dental Recruit	
DA	Dentalman Apprentice	Dental
DN	Dentalman	
FR	Fireman Recruit	
FA	Fireman Apprentice	Engineering
FN	Fireman	
HR	Hospitalman Recruit	
HA	Hospitalman Apprentice	Health
HN	Hospitalman	
SR	Seaman Recruit	
SA	Seaman Apprentice	Deck
SN	Seaman	

SOURCE: Author

TABLE 8

U.S. NAVY FOUR-YEAR OBLIGOR GROUPINGS

Occupational Fields	Ratings
General Seamanship	BM, SM
Ship Operations	OS, QM
Marine Engineering	BT, EN, GSM
Ship Maintenance	HT, IM, MR, ML, OM, PM, BR
Aviation Maintenance/Weapons	PR, AE, AD, AZ, AO, AM, AV, AF
Aviation Ground Support	AB, AS
Air Traffic Control	AC
Ordnance Systems	GM, NM, TM
Sensor Operations	EW, OT
Weapons Systems Support	TD
Data Systems	DP
Construction	BU, CE, CM, EA, EO, SW, UT, EQ
Health Care	DT, HM
Administration	LN, NC, PN, PC, YN, RP
Logistics	AK, DK, MS, SH, SK
Media	DM, JO, LI, PH
Musician	MU
Master-at-Arms	MA
Cryptology	CT (less CTM)
Communications	RM
Intelligence	IS
Meteorology	AG
Aviation Sensor Operations	AW

SOURCE: NEOCS

TABLE 9

U.S. NAVY SIX-YEAR OBLIGOR GROUPINGS

Occupational Fields	Rating
Marine Engineering	EM, GSE, IC, MM
Aviation Maintenance/Weapons	AQ, AT, AX
Weapons Control	ET, FT
Ordnance Systems	MT
Sensor Operations	ST
Data Systems	DS
Cryptology	CTM

SOURCE: NEOCS, Recruiting Manual

Additionally, to facilitate data analysis, for each rating there will be an aggregation of length of service based upon normal enlistment lengths. The ratings, with the exception of ratings which have a high percentage of six-year obligors, will be aggregated in accordance with Table 10. Since the six-year obligor group has, by definition, a significant percentage of six-year initial enlistment contracts, a separate aggregation scheme will be used, as presented in Table 11. This aggregation is an attempt to capture the effects of the longer initial enlistment contracts.

B. SUPPLY DETERMINATION

Two separate statistical models of sailor supply will be developed; Model #1 for high school degree graduate sailors

TABLE 10

LENGTH OF SERVICE GROUPINGS FOR FOUR-YEAR OBLIGORS

Group	LOS
1	0-4 years
2	5-8 years
3	9-12 years
4	13-20 years
5	21+ years

SOURCE: Author

TABLE 11

LENGTH OF SERVICE GROUPINGS FOR SIX-YEAR OBLIGORS

Group	LOS
1	0-4 years
2	5-6 years
3	7-8 years
4	9-12 years
5	13-20 years
6	21+ years

SOURCE: Author

and Model #2 for high quality sailors. In each model, accessions will be formulated as being determined by relative pay, unemployment, the size of the population cohort, and number of Navy recruiter man-years. The two models will be

developed by employing stepwise multiple regression analysis. The two models will take the following form:

Model #1 HS = f(RELPAY, UNEM, POP, NREC)

Model #2 HQ = f(RELPAY, UNEM, POP, NREC)

where,

HS = Number of non-prior service male high school graduate enlistment contracts per 1000 of the 17-21 year old population.

HQ = Number of non-prior service male Mental Categories I and II high school degree graduate enlistment contracts per 1000 of the 17-21 year old population.

RELPAY = Ratio of full-time earnings of 18 year old civilian males to first year's RMC.

UNEM = Unemployment rate for all civilians.

POP = Number of 17-21 year olds in the population.

NREC = Number of Navy recruiter man years per 1000 of the 17-21 year old population.

The data collected on all variables are annual values for each of the 43 Navy Recruiting Districts from October 1976 through September 1980, a total of 215 observations which are listed in Appendix A. The data on the variables in the supply model were made available by Lawrence Goldberg at the Center for Naval Analyses. The data to be utilized are a subset of the data set used by Goldberg in developing his enlistment supply models (Goldberg, 1981).

1. <u>The Dependent Variables</u>

a. High School Sailor Enlistment Rate (HS)

This is the enlistment rate for all non-prior service male enlistment contracts per 1000 of the 17-21 year old population. The high school sailor model will be used as the base case for comparison of alternative pay policies to meet the Navy's demand for high quality sailors (215 observations - Navy recruiting district specific).

b. High Quality Sailor Enlistment Rate (HQ)

The high quality sailor enlistment rate is the number of non-prior service Mental Categories I and II high school degree graduate enlistment contracts per 1000 of the 17-21 year old population (215 observations--Navy recruiting district specific). This enlistment rate will be utilized in building the model of Categories I and II HSDG's enlistment supply behavior.

2. <u>Predictors for Enlistment</u>

a. Relative Pay (RELPAY)

Relative pay is the ratio of full-time earnings of 18 year old civilian males divided by the first year's Regular Military Compensation (215 observations--county data mapped into Navy recruiting districts). Regular Military Compensation is composed of base pay, basic allowance for quarters (BAQ), basic allowance for subsistence (BAS), and the tax advantage computed for the BAQ and BAS, as BAQ and BAS are non-taxable. In tying the RMC to the civilian wages

by recruiting district, a measure of the relative financial attractiveness of the military to the enlistee is obtained.

b. Unemployment (UNEM)

There are many measures of the unemployment rate within the country. However, to chose among them is not necessarily a crucial task. As demonstrated by Fernandez, the youth unemployment rate and the all-civilian unemployment rate are linearly dependent (Fernandez, 1979). In view of this, the unemployment rate for all civilians within each recruiting district was selected for this study (215 observations based upon closest city to the Navy recruiting district).

c. Population (POP)

Since the 17-21 year old population pool is the source of the majority of the Navy's non-prior service enlistment contracts, the population of this age cohort will be used as the population variable in the enlistment supply equations (215 observations--Navy recruiting district specific).

d. Recruiters (NREC)

Recruiting effort has been previously demonstrated to be an important factor in determining enlistment supply behavior in the U.S. Navy (Fernandez, 1979; Goldberg, 1975, March and May, 1980; Morey, 1977). In this study, the number of Navy recruiter man-years per 1000 of the 17-21 year old population per recruiting district will be used to capture the effect of the recruiting effort (215 observations--recruiting district specific). While it is recognized that

there are spillover effects from other services' recruiters, this effect was found to be small (Goldberg, 1980), and will not be included in the model as a separate explanatory variable.

In earlier studies by Goldberg (Goldberg, 1975), it was demonstrated that advertising levels can affect enlistment behavior. Advertising effects will not be included in the model as an explanatory variable; these data are not readily available by recruiting district. Depending upon the advertising medium employed, there can be a great deal of overlapping coverage between some Navy Recruiting Districts. Additionally, in later studies by Goldberg, he has dropped the advertising variable from his models of enlistment supply behavior (Goldberg, 1980).

3. Modeling Considerations

The enlistment supply models developed will be used to generate two important outputs; the individual regression coefficients of the independent variables, and the elasticities of the independent variables. The coefficients are important because they show the magnitude and direction of the relationship between the dependent variable and explanatory variables. The elasticities are important in computing the percentage amount and direction of effect upon the dependent variable from a percent increase or decrease in one of the explanatory variables. The coefficients and elasticities are also important in assessing behavioral conformance

of the model to theoretical considerations of the relationship between the dependent and explanatory variables.

In particular, these models will be used to focus upon the effects of changes in relative pay. This necessitates performance of tests of the individual coefficients to ensure they are not equal to zero. Additionally, there must be confidence intervals constructed for the coefficients and for the elasticity values.

Since this model will be constructed using a combination of cross-sectional and time series data, there is a possibility of functional dependency among the dependent variables. Therefore, a test for collinearity among the explanatory variables will be undertaken. Other forms of dependency will be examined through the use of standard autocorrelation tests.

C. PAY POLICY DETERMINATION

In Chapter V the knowledge gained from the demand determination and supply determination chapters will be put together to examine two alternative pay systems for accessing the requisite quality mix of sailors into the Navy. The first pay system will be a uniform pay system under which high quality enlistees are paid more than other enlistees. Under both of these systems the level of pay will be increased to a level to ensure the quality mix of enlistees is maintained.

The total cost of enlistees for the first year of service will be calculated under the uniform pay system. A second total cost of enlistees for the first year of service will be calculated using a two-tier pay system. By subtracting the cost of the two-tier pay system from the cost of the uniform pay system, the amount of economic rent paid to those sailors who do not meet the high quality sailor standard can be estimated. This amount of economic rent will be used as a measure of the inefficiency of the uniform pay system in meeting the quality requirements of the all-volunteer Navy. The thesis concludes with a study summary and further research recommendations in Chapter VI.

III. DEMAND DETERMINATION

The Navy's demand for high quality sailors can be considered from two dimensions: the quantity of high quality sailors demanded as entry level personnel, and the quantity of high quality sailors utilized in different occupations. This chapter will provide empirical measures of both dimensions of demand.

A. ENTRY LEVEL

In this section we present both the Navy's stated accessioning policies for high school diploma sailors and data on the actual past accessions of high quality sailors. The Navy's accession policy is extracted from the Manpower Requirements Reports (MRR) for FY 1976 through FY 1980. These requirements are summarized in Table 12.

TABLE 12

NAVY MALE NPS ACCESSION GOALS

FY	Accession Goal	% HSDG	HSDG Accession Goal
1976	73,223	76	55,649
1976T	28,135	76	21,383
1977	86,480	76	51,888
1978	64,392	76	48,938
1979	59,059	76	44,885
1980	62,661	76	47,622

SOURCE: Production Summaries

From Table 12 it can be seen that from 1976 through 1980 the Navy had a goal that 76 percent of male accessions would be high school diploma graduates. However, in FY 1981 there was a change in Navy policy. The Navy now defines its accession quality goal in terms of mental categories as stated in the Manpower Requirements Report for Fiscal Year 1981 (MRR 1981).

> "In FY 1979, 76.1 percent of all non-prior service accessions were high school diploma graduates. In order to obtain a better balance between requirements and manpower supply, the Navy implemented a revised recruiting policy on 1 Oct 79. The Navy's former policy required 76.0 percent of male non-prior service accessions to be high school diploma graduates. Under the revised policy 74 percent of male non-prior service accessions must be in Mental Groups I/III Upper. This policy provides a better match between manpower supply and Navy requirements than did previous policy. It is expected that 72 percent of FY 1980 male non-prior service accessions will be high school diploma graduates."
> (MRR FY81)

To determine the Navy's practice with regard to quality standards for entry level personnel, accession data provided by the Defense Manpower Data Center (DMDC) were examined. Table 13 contains data on the number of non-prior service (NPS) personnel in Mental Categories I and II accessed into the Navy in three education categories: GED, high school diploma graduates, and those with education beyond their high school diploma. The data are presented for each fiscal year from FY 1976 (1 Oct 75 - 30 Sep 76) through FY 1981. In FY 1976, 1,978 (6.2%) of the NPS Mental Category I and II males were GED's, while 28,536 (89.5%) were High School

Diploma Graduates, and 1,379 (4.3%) had completed at least some college education.

TABLE 13

NAVY MALE NPS MENTAL GROUPS I AND II ACCESSIONS

FY	GED	HSDG	Some College
1976	1,978 (6.2)	28,536 (89.5)	1,379 (4.3)
1977	1,474 (5.2)	26,658 (90.3)	1,271 (4.5)
1978	1,958 (8.6)	17,247 (75.7)	3,576 (15.7)
1979	1,656 (8.4)	15,589 (79.1)	2,452 (12.5)
1980	2,618 (11.0)	18,561 (78.3)	2,530 (10.7)
1981	3,069 (11.4)	20,869 (75.6)	2,962 (11.0)

SOURCE: Author

In Table 14 the data are aggregated to yield the total number of high quality accessions and the percentage high quality accessions were of NPS male accessions for FY 1976 through FY 1981. The cost of combining General Educational Development (GED) certificate holders with high school diploma graduates is that the two groups having somewhat different average performances (e.g., attrition rates) in the military were thereby aggregated. However, because the investigator was unable to separate GED certificate holders from high school diploma graduates in all the data, for data capability, GED's were aggregated with high school diploma graduates. For example, in FY 1976 there were 31,893 high quality accessions, which was 35.6 percent of the total NPS male accessions. (Those in Mental Category I or II with a

GED are classified as high quality sailors for data compatibility between the entry level data and the utilization data). The data concerning mental group categorization have been renormed to correct the misnorming problem which occurred in the Armed Forces Qualification Test (AFQT).

TABLE 14

NAVY HIGH QUALITY MALE NPS ACCESSIONS BY FISCAL YEAR

Fiscal Year	Total
1976	31,893 (35.6)
1977	28,430 (30.1)
1978	22,781 (31.1)
1979	19,699 (28.7)
1980	23,704 (31.6)
1981	26,900 (33.6)

SOURCE: Author

B. UTILIZATION

A second dimension of the Navy's demand for high quality sailors is their utilization within the Navy. Data on Navy utilization of high quality sailors came from the Enlisted Master Record Loss and Edit File at the DMDC. The data examined contained some missing elements which prevented some individuals from being classified into the proper race or the proper mental group. In all cases of missing data elements, the individual was omitted from analysis. This omission policy did not bias the results to the extent the missing data was distributed the same as the data remaining

for analysis. In no case did the missing data amount to more than 19 percent of the group analyzed and, in general, was less than 10 percent.

Table 15 presents a summary of the education and mental group attainment of the inventory of enlisted males in the Navy on 31 March 1981. HSDG's (including GED's) constitute 86.8 percent of the males in the Navy on that date. Just over 45 percent of these HSDG's were classified as high quality, while 39.8 percent of the total males in the Navy were classified as high quality.

TABLE 15

ENLISTED MALES IN THE NAVY

% HQ	39.8
% HSDG	86.8
% HQ of HSDG	45.8

SOURCE: Author

An occupational analysis of the utilization of high quality personnel was accomplished using the NEOCS study (ref NEOCS) groupings for ratings partitioned into either six-year obligor or four-year obligor groups. A separate grouping was utilized for apprenticeship ratings. The results for the four-year obligor grouping are presented in Table 16. Table 16 presents data on the twenty-three occupational groups. The occupational grouping with the lowest proportion of high quality sailors was the Logistics group with 12.7 percent of the sailors

TABLE 16

NAVY ENLISTED MALES--FOUR-YEAR OBLIGOR RATINGS

NEOCS Group	N	% HSDG	% HQ of HSDG	% HQ of Group
General Seamanship	11,971	74.5	18.3	13.9
Ship Operations	11,683	87.2	46.3	40.4
Marine Engineering	21,117	77.8	30.5	23.7
Ship Maintenance	14,582	85.0	32.4	27.5
Aviation Maintenance/ Weapons	45,848	85.5	27.5	23.5
Air Ground Support	8,758	82.0	20.6	16.9
Air Traffic Control	2,056	94.7	61.9	58.6
Ordnance Systems	11,233	82.7	34.9	28.9
Sensor Operations	3,063	95.6	67.3	64.3
Weapons System Support	1,588	94.5	69.9	66.1
Data Systems	2,808	95.9	55.4	53.1
Construction	10,442	90.1	29.0	26.1
Health Care	14,987	96.1	46.7	44.9
Administration	17,222	91.3	30.4	27.8
Logistics	34,784	84.7	15.0	12.7
Media	3,297	95.1	51.5	49.0
Musician	675	98.4	57.2	56.3
Master-at-Arms	1,163	87.5	24.9	21.8
Cryptology	5,666	95.9	51.5	49.4
Communications	13,246	91.4	32.1	29.3
Intelligence	915	96.2	53.3	51.3
Meteorology	1,343	93.4	64.5	60.2
Aviation Sensor Operations	3,001	91.3	63.6	58.1
TOTAL	241,448	86.5	32.1	27.8

SOURCE: Author

classified as high quality. The Weapons System Support group had the highest proportion of high quality sailors with 66.1 percent. As can be seen from Table 16 there is a substantial variation in the occupational percentages of high quality sailors around the four-year obligor average of 27.8 percent high quality personnel.

The six-year obligor grouping utilizing the NEOCS study is presented in Table 17. The six year obligor group has a relatively small variation around the group average of 72.8 percent high quality sailors. The six-year obligor group with the lowest percentage of high quality sailors was the marine engineering group. There were 40,123 males in this rating group, with 93.2 percent possessing a high school diploma (including GED's). In the Marine Engineering group, 67.6 percent of the HSDG's were classified as high quality, while these high quality sailors comprised 62.9 percent of the males in the rating group.

TABLE 17

NAVY ENLISTED MALES--SIX YEAR OBLIGOR RATINGS

NEOCS Group	N	%HSDG	% HQ of HSDG	% HQ of Group
Marine Engineering	40,123	93.2	67.5	62.9
Aviation Maintenance/ Weapons	12,190	95.1	79.8	75.8
Weapons Control	22,741	98.1	86.8	85.1
Ordnance Systems	2,033	98.1	81.6	80.0
Sensor Operations	7,145	94.8	78.5	74.4
Data Systems	7,375	98.7	81.9	80.8
Cryptology	1,729	99.1	84.8	84.0
TOTAL	88,336	95.2	76.3	72.6

SOURCE: Author

It is interesting to note that the six year marine engineering group had a greater percentage of high quality sailors than all but two of the twenty-three occupational groupings for the four year obligors. For the total of all six-year obligor ratings, 72.6 percent of the sailors in these ratings were high quality sailors. Proportionately, more than twice as many of the six-year obligors were high quality sailors than was true of four-year obligors. As will be shown later in this chapter, six-year obligor ratings are preponderantly highly technical.

Since the NEOCS study did not include the Apprenticeship ratings, the Apprenticeship ratings partitioned into six groupings are presented in Table 18. In Table 18 for the Apprenticeship groups, the Dentalman group possessed the lowest percentage of high quality sailors with 16.5 percent. The Hospitalman group possessed the highest percentage, with 30.1 percent of them being classified as high quality.

TABLE 18

NAVY ENLISTED MALES--APPRENTICESHIP RATINGS

Rating	N	% HSDG	% HQ of HSDG	% HQ of Rating
Airman	21,088	77.8	28.1	21.9
Constructionman	865	86.7	31.6	27.4
Dentalman	623	91.3	18.1	16.5
Fireman	21,350	76.1	27.6	21.0
Hospitalman	5,625	89.5	33.7	30.1
Seaman	47,137	80.9	37.1	26.2
TOTAL	96,688	79.8	32.8	26.2

SOURCE: Author

To gain further insight into the occupational utilization of high quality sailors, a separate partitioning of the Navy ratings can be done by grouping the ratings according to the technical skill level required. (See Appendix A for a list of the ratings in each group.) This grouping is presented in Table 19. In Table 19 for the semi-technical group, there were 76,213 males in the group, with 82.3 percent possessing a high school diploma (including GED's). Of the HSDG's, 26.2 percent were classified as high quality, while these high quality sailors comprised 21.6 percent of the males in the rating group. By contrast, 75.2 percent of the 59,120 sailors in highly technical occupations were high quality sailors. The majority of sailors are in ratings categorized as technical, with 43.1 percent of them being high quality personnel.

The technical grouping of the Navy ratings does not include the Apprenticeship ratings. As indicated in Table 19, 44 percent of the sailors in other than apprenticeship ratings are high quality sailors. This can be compared with the 26.2 percent of apprentices who are high quality sailors as shown in Table 18.

To gain a longitudinal perspective on the utilization of high quality sailors, a partitioning of the Navy enlisted males by length of service (LOS) is presented in Table 20. From Table 20, the percentage of HSDG in each length of service group is monotonically increasing until the first

retirement opportunity at 20 years of service. The percentage of high quality sailors in these length of service groups increases through the 5-8 year group, and is then monotonically decreasing.

TABLE 19

NAVY ENLISTED MALES--TECHNICAL CATEGORIES

	N	% HSDG	% HQ of HSDG	% HQ
Semi-technical	76,213	82.3	26.2	21.6
Technical	156,790	89.9	47.9	43.1
Highly-technical	59,120	95.7	78.6	75.2
TOTAL	292,123	89.1	49.3	44.0

SOURCE: Author

TABLE 20

NAVY ENLISTED MALES BY LOS

LOS (in years)	N	% HSDG	% HQ of HSDG	% HQ
0-4	240,884	84.4	41.1	34.7
5-8	71,489	90.1	55.0	49.6
9-12	33,501	91.2	52.0	47.4
13-20	38,461	92.2	50.3	46.8
21+	9,291	89.2	49.0	43.7

SOURCE: Author

To further increase our understanding of longitudinal utilization of high quality sailors, we disaggregate the Navy enlisted males by length of service and by technical group. Also shown in Table 21, the percentage of high quality sailors for the

semi-technical group stays around 20 percent, with no discernible pattern over length of service. In the technical and highly-technical rating groups, there is a noticeable increase in percentage of high quality sailors from the 0-4 year length of service to the first retirement opportunity at 20 years of service.

The reader is cautioned in making conclusions about the data presented in Tables 20 and 21 since these are cross-sectional data on Navy enlisted males, and not cohort data. Appendix B contains a listing of high quality percentages by rating by length of service. The next chapter will present the enlistment supply models which result from the analysis of the supply data.

TABLE 21

% HIGH QUALITY NAVY ENLISTED MALES BY LOS
BY SEMI-TECHNICAL, TECHNICAL AND HIGHLY TECHNICAL GROUPINGS

LOS (in years)	Semi-Technical	Technical	Highly-Technical
0-4	22.3	38.6	69.3
5-8	21.7	47.5	79.2
9-12	23.5	48.5	78.9
13-20	18.0	49.7	84.2
21+	20.1	45.4	78.4

SOURCE: Author

IV. SUPPLY DETERMINATION

In this chapter the High School Diploma Graduate Enlistment Model and the High Quality Enlistment Model will be presented. They are both the result of stepwise linear regression.

Before attempting to fit the data to any model, a test of functional dependency among the explanatory variables wa performed. The test was one of computing the condition number of the explanatory variables matrix. The condition number was 547, indicating no significant functional dependency among the explanatory variables (Dahlquist and Bjorck; Belsley, Kuh, and Welsch). For a listing of the data utilized, the reader is referred to Appendix C.

A. THE SUPPLY MODELS

Several functional forms were attempted using the four explanatory variables: relative pay (RELPAY), unemployment rate (UNEM) number of Navy recruiters (NREC), and population (POP), in an effort to obtain a "good" fit. These models included linear, multiplicative, and logistic forms.

1. Linear Model

Table 22 is a presentation of the results of fitting the data to a linear model. The dependent variable in each model was the number of enlistments by recruiting district

for high school diploma graduate enlistments and for high quality enlistments, respectively. In both the high school diploma graduate enlistment model and the high quality enlistment model, the results, using an F-test, were found to be significant at the .001 level. Additionally, each of the coefficients of the explanatory variables were found to be significant at the .001 level utilizing an F-test.

The goodness of fit criterion was based upon R^2 adjusted for the degrees of freedom in the overall model. These two models had an adjusted R^2 of .806 for the high school diploma graduate enlistment model and .750 for the high quality enlistment model. The adjusted R^2 for these linear models were the highest of the functional model forms attempted.

TABLE 22

LINEAR REGRESSION RESULTS

Variable	HSDG Coefficient	HQ Coefficient
CONSTANT	-187.6734**	-328.4518**
RELPAY	-1341.169**	-400.5927**
UNEM	99.3973**	52.1994**
NREC	193.0531**	99.1871**
POP	6.0089**	2.2738**
Total Equation F	222.75**	161.52**
Adjusted R^2	.806	.750
Durbin-Watson	1.71*	1.69*

* significant at the .01 level
**significant at the .001 level

SOURCE: Author

The Durbin-Watson test was used to test for first-order autocorrelation among the explanatory variables. For both models the Durbin-Watson test showed no first-order autocorrelation at the .01 level.

2. Multiplicative Model

The results of the multiplicative models are presented in Table 23. In these models the dependent variable is the enlistment rate for high school diploma graduate sailors and the enlistment rate for high quality sailors. Performing an F-test on these two models, the results were found to be significant at the .001 level. The individual coefficients of each of the explanatory variables were also tested using an F-test. All of the coefficients in the high school diploma graduate enlistment model were found to be significant at the .001 level. In using an F-test of the coefficients in the high quality enlistment model, all of the coefficients were found to be significant at the .001 level.

The adjusted R^2 was .819 for the high school diploma graduate enlistment model and .757 for the high quality enlistment model. In testing for first-order autocorrelation, the Durbin-Watson test statistic was in the inconclusive range for both enlistment models.

3. Logistic Model

The final two models to be presented are of the logistic form. In these models the population variable was utilized to convert the number of enlistees by Navy recruiting

TABLE 23

MULTIPLICATIVE REGRESSION RESULTS

Variable	HSDG Coefficient	HQ Coefficient
CONSTANT	0.0103	-1.6159
RELPAY	-0.9561**	-0.7506**
UNEM	0.3597**	0.4106**
NREC	0.6013**	0.8609**
POP	1.0320**	1.0817**
Total Equation F	242.86**	167.77**
Adjusted R^2	.819	.757
Durbin-Watson	1.63	1.57

**significant at the .001 level

SOURCE: Author

district into an enlistment rate by Navy recruiting district. The assumption here is that enlistment rates are not a function of the size of the population eligible to enlist in the Navy.

Table 24 presents the results of the logistic model regressions. These results were found to be significant for the high school diploma graduate enlistment model and the high quality enlistement model at the .001 level, using an F-test. Additionally, using an F-test, the coefficients of all three explanatory variables in both models were found to be significant at the .001 level.

The adjusted R^2 for the high school diploma graduate enlistment model was .551, and for the high quality enlistment model it was .486. These adjusted R^2's are both nearly the same as the adjusted R^2's for the two multiplicative models developed. The results of the Durbin-Watson test found both models to be free from first-order autocorrelation.

TABLE 24

LOGISTIC REGRESSION RESULTS

Variable	HSDG Coefficient	HG Coefficient
CONSTANT	-2.8166	-4.3947
RELPAY	-1.0660**	-0.6898**
UNEM	0.0639**	0.0768**
NREC	0.1478**	0.1953**
Total Equation F	88.55**	68.45**
Adjusted R^2	.551	.486
Durbin-Watson	1.71*	1.66*

* significant at the .01 level
**significant at the .001 level

SOURCE: Author

B. RELATIVE PAY ELASTICITIES OF THE SUPPLY MODELS

Relative pay elasticities for all of the models developed are presented in Table 25. These elasticities were calculated using the average values of all observations on the variables. While the relative pay elasticities appear to be signed

improperly, this is not the case, since relative pay was defined as the civilian pay variable divided by the military pay variable. It is important to note the importance of the functional form when calculating the relative pay elasticities. Although the same data base is used, the relative pay elasticity from the high school diploma models range from .815 to .956, while the relative pay elasticity for the high quality enlistment models is between .602 and .751.

TABLE 25

RELATIVE PAY ELASTICITIES

Model Form	HSDG	HQ
Linear	-.8153	-.6099
Multiplicative	-.9561	-.7506
Logistic	-.8933	-.6016

SOURCE: Author

For all three functional forms of the enlistment models, the absolute values of the relative pay elasticity of the high school diploma graduate enlistment model are larger than the absolute values of the relative pay elasticity of the high quality enlistment model. This indicates that a larger percentage increase in military pay relative to civilian pay is required to obtain the same percentage increase in high quality enlistments as compared to high school diploma graduate enlistments.

These elasticities, although larger in magnitude, confirm the relative ranking of Morey's relative pay elasticities. Morey obtained relative pay elasticities of .179 and .025 for high school diploma graduate enlistees and upper-mental group (I-IIIA) high school diploma graduate enlistees, respectively (Morey). The elasticities do, however, conflict with those obtained by Goldberg in his recent studies. Goldberg calculated relative pay elasticities to be -.915 and -.949 for high school diploma graduate enlistees and high quality enlistees, respectively. Since Goldberg calculated the absolute value of the relative pay elasticity for high quality enlistments to be greater than the absolute value of the relative pay elasticity for high school diploma graduate enlistments, this means that the high quality enlistments are slightly more responsive to a given change in the relative pay than are high school diploma graduate enlistments. This result is probably due to Goldberg's use of an unusual, non-standard functional form and the use of a greater number of explanatory variables. Goldberg's model may be good for predictive purposes but is poor for measurement of individual effects. A summary of the pay elasticities from various studies is presented in Table 26 to facilitate comparison.

In this study, the high school diploma graduate enlistments were much more responsive to an increase in military pay than were high quality enlistments. Using the ratio of HSDG relative pay elasticity, for each functional form, the HSDG

enlistees were 37 to 48 percent more responsive to a military pay increase than were the HQ enlistees.

TABLE 26

PAY ELASTICITIES FROM VARIOUS STUDIES

Author	HSDG	HQ
Fernandez (a)	----	.63
Grissmer (a)	----	.94
Goldberg (b)	-.92	-.95
Morey (a)	.18	.03
This thesis:		
Linear	-.82	-.61
Multiplicative	-.96	-.75
Logistic	-.89	-.60

SOURCE: (a) Sinaiko
(b) Goldberg, 1981

The next chapter will utilize the results of this supply determination chapter to explore alternative compensation policies.

V. AN APPLICATION OF THE DEMAND AND SUPPLY ANALYSES

This chapter will present an application of the demand and supply analysis to evaluate alternative policies for obtaining a desired increase in total high school diploma graduate (HSDG) enlistees. For the purposes of this analysis, the multiplicative enlistment supply models have been selected.

In selecting the functional form of the enlistment supply model to be used for this application, R^2 was not used as a model selection criterion. The logistic enlistment supply mdoels predict an enlistment rate, while the linear and multiplicative enlistment supply models predict the number of enlistments. This presents a scaling problem in the dependent variable and does not allow for a direct comparison of the adjusted R^2's. The logistic enlistment supply models were transformed mathematically to allow for prediction of the number of enlistments. The transformed models were then used with the observations on the explanatory variables to obtain predicted values for the dependent variables. From these predicted values and the observed values of the dependent variables, new adjusted R^2's were calculated. This resulted in an R^2 of .842 for the logistic high school diploma graduate enlistment supply model and .773 for the logistic high quality enlistment supply model. These new adjusted

R^2's are presented in Table 27 with the adjusted R^2's from the other enlistment supply models.

TABLE 27

ADJUSTED R^2'S

	HSDG	HQ
Linear	.806	.750
Multiplicative	.819	.757
Logistic	.842	.773

SOURCE: Author

The R^2's presented in Table 1 are directly comparable, since they were all calculated for models predicting the same dependent variable. Because of the small difference in these adjusted R^2's, adjusted R^2 was not used as a criterion for choosing amongst the model functional forms.

The multiplicative enlistment supply models were selected because they have several properties which make them more desirable than the other enlistment supply model functional forms. First, for the high school enlistment supply models and the high quality enlistment supply models, the absolute value of the relative pay elasticity from the multiplicative functional form is the largest. Using the multiplicative model to derive the change in military pay necessary to achieve a given increase in enlistments would result in an understatement of the military pay increase necessary should one of the other functional forms be more correct. Second,

the difference between the relative pay elasticity for the high school diploma graduate enlistment supply model and the relative pay elasticity for the high quality enlistment supply model is smallest in the multiplicative enlistment supply models. Using the multiplicative models when one of the other forms is correct results in an understatement of the differences in the effect of a change in military pay on high quality enlistees as opposed to high school diploma enlistees. Finally, the multiplicative enlistment supply models are simple. The elasticity with respect to enlistments of each explanatory variable is given by the respective exponent of the explanatory variable. The elasticities for the multiplicative form from Table 25 in Chapter IV are constant, not varying with factor levels of the explanatory variables.

A. UNIFORM PAY SYSTEM

The usefulness of the high quality enlistment model may be demonstrated by the following example. Table 28 presents the data on male NPS enlistees for Fiscal Year 1980.

TABLE 28

1980 MALE NPS ENLISTEES

HQ	23,704
HSDG	61,340
Non-HSDG	13,707
Total	75,047

SOURCE: Defense Manpower Data Center

Assume the Navy increased demand for high school diploma graduate enlistments by 10,000 from the base number of enlistees from 1980. The additional 10,000 high school diploma graduate enlistees represent a 16.3 percent increase from the 61,340 enlistees in the base year (10,000/61,340 = 16.3%).

The change in relative pay necessary to obtain a 16.3% increase in high school diploma graduate enlistees is given by

$$\text{change in relative pay} = \frac{\text{\% change in enlistment requirements}}{\text{relative pay elasticity}}$$

$$= \frac{16.3\%}{.956}$$

$$= 17.1\%$$

Using the average relative pay ratio of .939 for the 43 remaining districts in the base year of 1980, the change in military pay necessary to achieve a 17.1 percent change in relative civilian pay is given by

$$\text{change in military pay} = \frac{\text{change in relative pay}}{\text{relative pay ratio}}$$

$$= \frac{17.1\%}{.939}$$

$$= 18.2\%$$

Thus, the application of the high school diploma graduate supply model leads us to conclude that 18.2 percent increase in military pay would yield a 10,000 person increase in high school diploma graduate enlistees.

However, this analysis is flawed. Since the pay elasticity for high quality enlistees is smaller than the pay elasticity of the high school diploma graduate enlistees, the pay change will result in a smaller percentage increase in high quality enlistees. More precisely, the high quality pay elasticity is only 78.6 percent (HQ elasticity/HSDG elasticity = .751/.956 = .786) of the high school diploma graduate pay elasticity. The quality mix of 1980 HSDG enlistments was 38.6 percent high quality enlistees (i.e., 1980 HQ/1980 HSDG = 23,704/61,340 = .386). To maintain the quality mix, we want 3,860 of the increased 10,000 high school diploma graduate enlistees to be high quality enlistees. Instead, the military pay change of 18.2 percent would only yield 3,034 (.786 x 3,860) high quality enlistees.

Thus, continued application of the high school diploma graduate model to calculate military pay changes needed to accomplish desired goals of high school diploma graduate enlistees will fail to produce the proper quality mix of enlistees. In particular, this procedure would lead to a decreasing proportion of high quality enlistees.

There are several remedies to this deficiency. One is to raise military pay the amount necessary to attract the desired quantity of high quality enlistees. In the example above, this means deriving the military pay change necessary to attract 16.3 percent more high quality enlistees.

The change in relative pay necessary to obtain a 16.3 percent increase in high quality enlistees is given by

$$\text{change in relative pay} = \frac{\text{\% change in enlistment requirements}}{\text{relative pay elasticity}}$$

$$= \frac{16.3\%}{.751}$$

$$= 21.7\%$$

The change in military pay necessary to achieve a 21.7 percent change in relative pay is given by

$$\text{change in military pay} = \frac{\text{\% change in relative pay}}{\text{relative pay ratio}}$$

$$= \frac{21.7\%}{.939}$$

$$= 23.1\%$$

The application of the high quality supply model leads us to conclude that a 23.1 percent increase in military pay is necessary to maintain the base proportion of high quality enlistees, i.e., to obtain 3,860 additional high quality enlistees. Since this is greater than the 18.2 percent increase derived from the high school diploma graduate supply model, it would also yield an oversupply of high school diploma graduates.

The resultant oversupply of high school diploma graduate enlistees means that the high school diploma graduate enlistees will be paid more than is necessary to enlist them. This result will always occur when a uniform pay system is used to generate the desired number of high quality recruits.

B. TWO-TIER PAY SYSTEM

Alternatively, the supply models can be used to determine the military pay necessary under a two-tier pay system to attract the desired increase in both high school diploma graduate and high quality enlistees. This would entail paying the high school diploma graduate enlistees 18.2 percent more than in 1980 and paying the high quality enlistees 23.1 percent more than in 1980.

In terms of total pay to enlistees, the two-tier pay system would result in a lower cost method of obtaining the desired proportion of high quality enlistees. Using the resular military compensation level for the first year of enlistment from 1980 was \$8,175 (Goldberg, 1981). The high quality supply model under a single pay system implies a 23.1 percent increase in pay necessary to maintain the desired proportion of high quality enlistees. Therefore, the total pay to enlistees would be given by

$$\begin{aligned}\text{Total pay} &= \left(\begin{matrix}\text{Total HSDG and}\\ \text{HQ enlistees}\end{matrix}\right) \times (1 + \text{pay increase}) \times \left(\begin{matrix}1980\\ \text{RMC}\end{matrix}\right)\\ &= 71{,}340 \times 1.231 \times \$8{,}175\\ &= \$717.9 \text{ million}\end{aligned}$$

Under a two-tier pay system, the high school diploma graduate enlistments are paid the 18.2% increment in pay required to enlist them and high quality enlistees are paid the 23.1% increment necessary to enlist their required amount. The total cost of enlistees in the first year of

service after enlistment is the sum of these two amounts. Using the results from both supply models with a two-tier pay system, the total pay to enlistees would be given by

$$\begin{aligned}\text{Total pay} &= \binom{\text{HSDG}}{\text{enlistees}} \times \left(1 + \frac{\text{HSDG pay}}{\text{increase}}\right) \times \binom{1980}{\text{RMC}} + \binom{\text{HQ}}{\text{enlistees}} \\ &\quad \times \left(1 + \frac{\text{HQ pay}}{\text{increase}}\right) \times \binom{1980}{\text{RMC}} \\ &= (37{,}636 \times 1.182 \times \$8{,}175) + (23{,}704 \times 1.231 \times \$8{,}175) \\ &= \$602.2 \text{ million}\end{aligned}$$

The amount of economic rent paid to the high school diploma graduate enlistees as a result of continuing the uniform pay policy is given by

$717.9 million - $602.2 million = $115.7 million.

The $115.7 million is a lower limit on the amount of economic rent, in that it considers only male high school diploma graduate enlistees and male high quality enlistments. Women and those who do not possess a high school diploma would also have to be added into the calculations to obtain a more accurate estimate of the economic rent under the current pay system. The next chapter will present the summary of and recommendations for further research from this study.

VI. CONCLUSIONS

A. SUMMARY

This study examined two groups of Navy non-prior service male enlistments; high school diploma graduate enlistments in all mental categories and high school diploma graduate enlistments in Mental Categories I and II. The latter group was defined to be "high quality" enlistees. A rationale for interest in high quality enlistments was presented. An empirical analysis of the Navy's demand for high quality enlistees was accomplished using the Enlisted Active Duty Military Master and Loss and Edit File.

Several supply models of high school diploma graduate enlistments and of high quality enlistments were developed using data furnished by Lawrence Goldberg from the Center for Naval Analyses. Of these, the muliplicative enlistment supply models were then used to examine alternative pay systems assuming an increasing requirement for enlistees into the Navy.

In the application of the enlistment supply models to derive military pay changes necessary to satisfy an increased demand for high school diploma graduate enlistees it was discovered that resultant policy would guarantee a decreasing quality mix of enlistees. This is because of the different pay elasticities for high quality enlistees vis-a-vis high

school diploma graduate enlistees. High quality enlistments were shown to be about 78 percent as responsive to military pay increases as were high school diploma graduate enlistments. This result implies that a two-tier pay system would be more efficient if the Navy were to attempt to maintain a desired quality mix while increasing the number of enlistees required. Under a two-tier pay system the high quality enlistees would be paid more than the high school diploma graduate enlistees. This two-tier pay system would also result in a savings of $115.7 million to the Navy under a scenario of 10,000 increased demand for high school diploma graduate enlistees and a maintenance of a constant quality mix.

Currently the "Navy pays $2000 extra to those willing to learn nuclear skills or how to be boiler technicians (Fialka)." The analysis accomplished for this thesis did not include a specific look at nuclear versus non-nuclear skills. However, to the extent that the nuclear skills are classified as six-year obligor ratings (due to the additional time required for nuclear power training), the Navy may already be paying enlistees based upon their quality. The six-year obligor ratings on average possessed 72.6 percent high quality sailors are more productive than other sailors independent of the occupation to which they are assigned, then perhaps bonuses should be based upon input characteristics.

B. AREAS FOR FURTHER RESEARCH

The first area for further research is to test the models developed in this study with Fiscal Year 1981 data. The predicted numbers of 1981 high school diploma graduate enlistees and 1981 high quality enlistees using the models developed in this thesis can be compared to the actual numbers of 1981 high school diploma graduate enlistees and high quality enlistees. A projected quality mix of enlistees can also be predicted and compared to the actual quality mix of Fiscal Year 1981 enlistees.

A second area for further research involves identifying and removing the GED certificate holders from the high quality category, inasmuch as their attrition rate is not quite as good as the attrition rates for high school diploma graduate enlistees (Elster).

A third area for further research involves providing a better empirical foundation for the models. In particular, we need to develop a better understanding of the effects of unemployment and the interrelationships among the explanatory variables. More work needs to be undertaken on development of supply models for separate racial and gender groupings.

Finally, additional work in the area of sailor productivity is needed. Research needs to be done on the relationship of entry characteristics such as Categories I and II HSDG to actual performance. Pay grade attainment may be a very poor proxy for productivity.

APPENDIX A

TECHNICAL SKILL REQUIREMENTS FOR U. S. NAVY RATINGS

Semi-Technical		Technical					Highly Technical	
ABE	MS	AD	BU	EM	IS	PM	AC	ET
ABF	PC	AG	CE	EN	JO	PR	AE	EW
ABH	PN	AME	CM	EO	ML	QM	AQ	PTB
AK	RP	AMH	CTA	GMG	MM	RM	AT	FTG
BM	SH	AMS	CTO	GMM	MN	SW	AX	FTM
BT	SK	AO	CTR	GMT	MR	TM	CTI	MT
HT	SM	ASE	DK	GSE	MU	UT	CTM	STG
LI	YN	ASH	BM	GSM	OM		CTT	STG
		ASM	DP	HM	OS		DS	TD
		AW	DT	IC	OT			
		AZ	EA	IM	PH			

APPENDIX B

U.S. NAVY RATINGS BY LOS

Those ratings annotated with an * are classified as six-year obligor ratings and are grouped by LOS according to Table 11 in Chapter III. All other ratings are grouped by LOS according to Table 10 in Chapter III.

AVIATION BOATSWAIN'S MATE (AB)

LOS	N	% HQ
4	12	41.7
5	62	33.9
Total	74	35.1

AVIATION BOATSWAIN'S MATE--
LAUNCHING AND RECOVERY (ABE)

LOS	N	% HQ
1	1,085	11.1
2	345	25.5
3	158	17.7
4	63	44.4
5	11	18.2
Total	1,662	16.0

AVIATION BOATSWAIN'S MATE--
FUELS (ABF)

LOS	N	% HQ
1	50	8.8
2	369	16.5
3	181	22.7
4	71	28.2
5	17	17.6
Total	1,488	13.4

AVIATION BOATSWAIN'S MATE--
AIRCRAFT HANDLING (ABH)

LOS	N	% HQ
1	1,438	11.8
2	669	14.1
3	307	12.7
4	152	23.0
5	49	20.4
Total	2,615	13.3

AIR TRAFFIC CONTROLLER (AC)

LOS	N	% HQ
1	826	68.6
2	409	63.6
3	252	66.7
4	167	77.8
5	107	61.7
Total	1,761	67.6

AVIATION MACHINIST'S MATE (AD)

LOS	N	% HQ
1	5,942	15.8
2	1,634	32.1
3	1,347	36.7
4	1,295	43.9
5	375	44.0
Total	10,593	25.4

AVIATION ELECTRICIAN'S MATE (AE)

LOS	N	% HQ
1	3,290	31.1
2	1,183	40.7
3	882	50.7
4	722	58.3
5	189	57.7
Total	6,266	39.6

AVIATION MAINTENANCEMAN (AF)

LOS	N	% HQ
4	8	75.0
5	230	48.3
Total	238	49.2

AEROGRAPHER'S MATE (AG)

LOS	N	% HQ
1	623	65.0
2	235	68.9
3	132	63.6
4	133	71.4
5	78	66.7
Total	1,201	66.4

AVIATION STOREKEEPER (AK)

LOS	N	% HQ
1	1,252	23.3
2	617	19.8
3	477	15.9
4	464	12.7
5	106	21.7
Total	2,916	19.6

AVIATION STRUCTURAL MECHANIC (AM)

LOS	N	% HQ
4	60	40.0
5	155	38.1
Total	215	38.6

AVIATION STRUCTURAL MECHANIC-- SAFETY EQUIPMENT (AME)

LOS	N	% HQ
1	1,332	12.0
2	434	26.7
3	260	47.7
4	259	53.7
5	38	44.7
Total	2,313	24.0

AVIATION STRUCTURAL MECHANIC--
HYDRAULIC EQUIPMENT (AMH)

LOS	N	% HQ
1	2,193	11.7
2	1,065	23.5
3	733	30.8
4	434	39.6
5	88	42.0
Total	4,513	20.9

AVIATION STRUCTURAL MECHANIC--
STRUCTURES (AMS)

LOS	N	% HQ
1	3,633	12.1
2	1,258	24.1
3	756	33.2
4	594	43.6
5	121	33.9
Total	6,362	20.3

AVIATION ORDNANCEMAN (AO)

LOS	N	% HQ
1	2,853	11.3
2	1,028	24.0
3	597	37.2
4	492	51.8
5	123	35.0
Total	5,093	21.4

AVIATION FIRE CONTROL TECHNICIAN (AQ)*

LOS	N	% HQ
1	1,329	70.1
2	356	84.6
3	215	82.3
4	311	87.8
5	28	75.0
Total	2,239	76.1

AVIATION SUPPORT EQUIPMENT TECHNICIAN (AS)

LOS	N	% HQ
2	6	33.3
3	131	61.8
4	211	44.5
5	59	39.0
Total	407	49.1

AVIATION SUPPORT EQUIPMENT TECHNICIAN--
ELECTRICAL (ASE)

LOS	N	% HQ
1	221	38.5
2	104	47.1
3	39	35.9
4	6	0.0
Total	370	40.0

AVIATION SUPPORT EQUIPMENT TECHNICIAN--
HYDRAULIC AND STRUCTURES (ASH)

LOS	N	% HQ
1	223	24.7
2	102	31.4
3	51	39.2
4	19	26.3
Total	395	28.4

AVIATION SUPPORT EQUIPMENT TECHNICIAN--
MECHANICAL (ASM)

LOS	N	% HQ
1	408	22.3
2	149	28.9
3	87	13.8
4	21	19.0
5	1	0.0
Total	706	22.5

AVIATION ELECTRONICS TECHNICIAN (AT)*

LOS	N	% HQ
1	4,891	70.0
2	1,454	80.5
3	568	79.8
4	1,051	85.5
5	255	85.5
Total	8,219	75.0

AVIONICS TECHNICIAN (AV)

LOS	N	% HQ
4	8	87.5
5	153	82.4
Total	161	82.6

AVIATION ASW OPERATOR (AW)

LOS	N	% HQ
1	1,261	58.4
2	694	70.3
3	272	74.3
4	246	84.6
5	102	82.4
Total	2,575	66.7

AVIATION ASW TECHNICIAN (AX)*

LOS	N	% HQ
1	957	76.8
2	285	80.4
3	112	76.8
4	152	83.6
5	36	97.2
Total	1,542	78.6

AVIATION MAINTENANCE ADMINISTRATIONMAN (AZ)

LOS	N	% HQ
1	969	23.0
2	456	27.9
3	347	30.8
4	348	38.8
5	57	36.8
Total	2,177	28.2

BOATSWAIN'S MATE (BM)

LOS	N	% HQ
1	2,397	12.4
2	1,921	13.5
3	1,164	14.9
4	1,019	17.4
5	362	12.2
Total	6,863	13.8

BOILER TECHNICIAN (BT)

LOS	N	% HQ
1	6,977	24.9
2	2,151	18.7
3	800	30.5
4	619	28.4
5	180	21.1
Total	10,727	24.2

BUILDER (BU)

LOS	N	% HQ
1	1,423	27.8
2	444	32.7
3	196	25.2
4	194	37.1
5	35	25.7
Total	2,292	30.1

CONSTRUCTION ELECTRICIAN (CE)

LOS	N	% HQ
1	516	34.1
2	253	39.1
3	112	42.9
4	126	46.0
5	12	66.7
Total	1,019	38.2

CONSTRUCTION MECHANIC (CM)

LOS	N	% HQ
1	781	24.8
2	292	34.6
3	105	42.9
4	159	39.0
5	16	37.5
Total	1,353	30.2

CRYPTOLOGIC TECHNICIAN--
ADMINISTRATIVE (CTA)

LOS	N	% HQ
1	179	25.7
2	187	50.3
3	135	62.2
4	101	73.3
5	41	58.5
Total	643	50.1

CRYPTOLOGIC TECHNICIAN--
INTERPRETIVE (CTI)

LOS	N	% HQ
1	603	75.5
2	697	84.4
3	133	95.5
4	238	96.6
5	35	97.1
Total	1,706	84.1

CRYPTOLOGIC TECHNICIAN--
MECHANICAL (CTM)*

LOS	N	% HQ
1	1,070	78.3
2	297	90.9
3	89	91.0
4	238	96.6
5	35	97.1
Total	1,729	84.0

CRYPTOLOGIC TECHNICIAN--
COMMUNICATIONS (CTO)

LOS	N	% HQ
1	421	41.6
2	329	48.9
3	168	67.9
4	176	75.6
5	45	51.1
Total	1,139	53.2

CRYPTOLOGIC TECHNICIAN--
COLLECTION (CTR)

LOS	N	% HQ
1	441	30.2
2	307	44.6
3	146	65.1
4	279	68.5
5	66	57.6
Total	1,239	47.9

CRYPTOLOGIC TECHNICIAN--
TECHNICAL (CTT)

LOS	N	% HQ
1	414	31.9
2	297	42.8
3	142	75.4
4	288	76.4
5	42	69.0
Total	1,183	52.0

CONSTRUCTIONMAN (CU)

LOS	N	% HQ
4	3	100.0
5	21	76.2
Total	24	79.2

Total

DISBURSING CLERK (DK)

LOS	N	% HQ
1	622	31.4
2	442	22.6
3	213	15.0
4	412	10.2
5	77	16.9
Total	1,766	21.6

ILLUSTRATOR DRAFTSMAN (DM)

LOS	N	% HQ
1	92	30.4
2	76	28.9
3	37	40.5
4	47	42.6
5	21	71.4
Total	273	36.6

DATA PROCESSING TECHNICIAN (DP)

LOS	N	% HQ
1	1,248	60.4
2	579	57.0
3	233	57.5
4	348	56.9
5	65	50.8
Total	2,463	58.6

DATA SYSTEMS TECHNICIAN (DS)*

LOS	N	% HQ
1	1,703	79.2
2	402	86.1
3	72	80.6
4	176	86.4
5	9	77.8
Total	2,362	80.9

DENTAL TECHNICIAN (DT)

LOS	N	% HQ
1	641	19.0
2	594	26.4
3	236	36.4
4	214	46.3
5	75	48.0
Total	1,760	28.4

ENGINEERING AID (EA)

LOS	N	% HQ
1	170	71.8
2	43	60.5
3	24	41.7
4	47	34.0
5	5	60.0
Total	289	61.2

ELECTRICIAN'S MATE (EM)*

LOS	N	% HQ
1	7,493	66.4
2	1,669	51.0
3	479	68.3
4	974	45.9
5	266	58.3
Total	10,881	62.1

ENGINEMAN (EN)

LOS	N	% HQ
1	4,548	20.4
2	1,125	26.9
3	605	25.1
4	808	31.7
5	180	35.0
Total	7,266	23.5

EQUIPMENT OPERATOR (EO)

LOS	N	% HQ
1	1,044	26.0
2	344	26.7
3	96	36.8
4	213	33.8
5	15	6.7
Total	1,711	27.5

EQUIPMENTMAN (EQ)

LOS	N	% HQ
3	1	0.0
5	19	73.7
Total	20	70.0

ELECTRONICS TECHNICIAN (ET)*

LOS	N	% HQ
1	10,591	86.0
2	2,058	92.2
3	806	90.4
4	1,508	94.9
5	255	88.6
Total	15,218	88.0

ELECTRONIC WARFARE TECHNICIAN (EW)

LOS	N	% HQ
1	883	76.2
2	568	85.9
3	137	87.6
4	167	80.8
5	40	80.0
Total	1,795	80.7

FIRE CONTROL TECHNICIAN (FT)*

LOS	N	% HQ
4	131	90.8
5	108	88.9
Total	239	90.0

FIRE CONTROL TECHNICIAN--
BALLISTIC MISSILE FIRE CONTROL (FTB)*

LOS	N	% HQ
1	670	82.4
2	151	92.7
3	65	95.4
4	75	89.3
5	5	60.0
Total	966	87.8

FIRE CONTROL TECHNICIAN--
GUN FIRE CONTROL (FTG)*

LOS	N	% HQ
1	1,988	74.1
2	431	81.9
3	148	78.4
4	287	85.7
5	30	60.0
Total	2,884	76.5

FIRE CONTROL TECHNICIAN--
SURFACE MISSILE FIRE CONTROL (FTM)*

LOS	N	% HQ
1	2,298	74.2
2	429	83.9
3	88	85.2
4	255	88.2
5	11	90.9
Total	3,081	77.1

GUNNER'S MATE (GM)

LOS	N	% HQ
4	13	53.8
5	78	14.1
Total	91	19.8

GUNNER'S MATE--GUNS (GMG)

LOS	N	% HQ
1	1,402	30.6
2	657	35.9
3	449	36.1
4	360	27.8
5	65	9.2
Total	2,933	31.8

GUNNER'S MATE--MISSILE (GMM)

LOS	N	% HQ
1	717	34.0
2	323	40.2
3	104	54.8
4	107	69.2
5	8	50.0
Total	1,259	40.4

GUNNER'S MATE--TECHNICIAN (GMT)

LOS	N	% HQ
1	906	24.8
2	395	38.0
3	145	49.7
4	167	65.9
5	53	54.7
Total	1,666	35.2

GAS TURBINE SYSTEMS TECHNICIAN (GS)

LOS	N	% HQ
4	19	68.4
5	12	58.3
Total	31	64.5

GAS TURBINE SYSTEMS TECHNICIAN--
ELECTRICAL (GSE)*

LOS	N	% HQ
1	322	73.0
2	101	76.2
3	42	73.8
4	57	68.4
5	1	0.0
Total	523	73.0

GAS TURBINE SYSTEMS TECHNICIAN--
MECHANICAL (GSM)

LOS	N	% HQ
1	495	73.5
2	230	61.7
3	95	54.7
4	96	62.5
5	7	28.6
Total	923	67.2

HOSPITAL CORPSMAN (HM)

LOS	N	% HQ
1	4,054	60.1
2	3,229	56.3
3	1,861	47.0
4	1,419	55.3
5	502	42.0
Total	11,065	55.3

HULL MAINTENANCE TECHNICIAN (HT)

LOS	N	% HQ
1	6,140	27.5
2	1,751	35.9
3	888	34.3
4	795	28.1
5	174	21.8
Total	9,748	29.6

INTERIOR COMMUNICATION TECHNICIAN (IC)*

LOS	N	% HQ
1	3,598	58.9
2	696	60.7
3	238	77.3
4	347	65.1
5	61	68.9
Total	4,890	60.6

INSTRUMENTMAN (IM)

LOS	N	% HQ
1	162	37.7
2	55	43.6
3	51	58.8
4	41	68.3
5	6	66.7
Total	315	46.7

INTELLIGENCE SPECIALIST (IS)

LOS	N	% HQ
1	393	53.4
2	162	67.3
3	114	63.2
4	102	60.8
5	24	58.3
Total	795	58.7

JOURNALIST (JO)

LOS	N	% HQ
1	255	65.9
2	141	61.0
3	83	60.2
4	61	49.2
5	22	72.7
Total	562	62.3

LITHOGRAPHER (LI)

LOS	N	% HQ
1	141	12.1
2	97	22.7
3	53	20.8
4	39	25.6
5	8	50.0
Total	338	18.9

LEGALMAN (LN)

LOS	N	% HQ
1	8	50.0
2	45	51.1
3	55	50.9
4	75	53.3
5	25	44.0
Total	208	51.0

MASTER-AT-ARMS (MA)

LOS	N	% HQ
1	2	50.0
2	45	48.9
3	191	26.2
4	423	29.9
5	79	39.2
Total	740	31.1

MOLDER (ML)

LOS	N	% HQ
1	106	22.6
2	26	30.8
3	17	41.2
4	16	43.8
5	8	62.5
Total	173	29.5

MACHINIST'S MATE (MM)*

LOS	N	% HQ
1	17,378	63.8
2	3,289	63.5
3	1,031	70.0
4	1,430	60.6
5	336	44.9
Total	23,463	63.6

MINEMAN (MN)

LOS	N	% HQ
1	202	24.3
2	101	39.6
3	79	50.6
4	58	53.4
5	32	40.6
Total	472	36.7

MACHINERY REPAIRMAN (MR)

LOS	N	% HQ
1	1,150	32.9
2	447	28.2
3	249	36.9
4	235	40.9
5	48	33.3
Total	2,129	33.3

MESS MANAGEMENT SPECIALIST (MS)

LOS	N	% HQ
1	6,113	15.8
2	2,208	16.2
3	1,141	12.8
4	3,130	5.6
5	358	3.9
Total	12,950	12.8

MISSILE TECHNICIAN (MT)*

LOS	N	% HQ
1	1,237	78.3
2	444	82.9
3	159	76.7
4	172	88.4
5	11	72.7
Total	2,023	80.0

MUSICIAN (MU)

LOS	N	% HQ
1	143	69.2
2	127	68.5
3	125	64.8
4	112	62.5
5	47	61.7
Total	554	66.1

NAVY COUNSELOR (NC)

LOS	N	% HQ
2	16	50.0
3	198	40.4
4	422	44.5
5	221	33.9
Total	857	41.0

OPTICALMAN (OM)

LOS	N	% HQ
1	103	43.7
2	45	51.1
3	44	63.6
4	34	79.4
5	13	69.2
Total	239	55.2

OPERATIONS SPECIALIST (OS)

LOS	N	% HQ
1	4,488	46.1
2	1,325	57.1
3	580	57.1
4	423	60.8
5	175	58.9
Total	6,991	50.3

OCEAN SYSTEMS TECHNICIAN (OT)

LOS	N	% HQ
1	367	36.8
2	232	59.5
3	117	71.8
4	162	75.3
5	31	71.0
Total	909	55.1

POSTAL CLERK (PC)

LOS	N	% HQ
1	418	36.4
2	170	31.2
3	126	15.9
4	95	29.5
5	27	29.6
Total	836	31.2

PHOTOGRAPHER'S MATE (PH)

LOS	N	% HQ
1	969	65.5
2	346	64.2
3	108	54.6
4	176	58.5
5	68	67.6
Total	1,667	63.9

PRECISION INSTRUMENTMAN (PI)

LOS	N	% HQ
5	4	100.0
Total	4	100.0

Total		

PATTERNMAKER (PM)

LOS	N	% HQ
1	58	36.2
2	12	25.0
3	17	47.1
4	28	21.4
5	5	40.0
Total	62	30.6

PERSONNELMAN (PN)

LOS	N	% HQ
1	1,968	46.1
2	1,127	44.3
3	683	49.3
4	612	32.4
5	257	30.0
Total	4,647	43.4

AIRCREW SURVIVAL EQUIPMENTMAN (PR)

LOS	N	% HQ
1	722	21.9
2	313	38.0
3	202	52.5
4	164	45.7
5	72	30.6
Total	1,473	32.6

QUARTERMASTER (QM)

LOS	N	% HQ
1	1,944	30.1
2	607	42.2
3	362	38.7
4	296	43.9
5	133	36.8
Total	3,342	34.7

RADIOMAN (RM)

LOS	N	% HQ
1	5,706	24.4
2	2,296	36.4
3	1,441	41.7
4	1,440	49.0
5	526	43.7
Total	11,409	33.0

RELIGIOUS PROGRAM (RP)

LOS	N	% HQ
1	144	46.5
2	52	50.0
3	41	43.9
4	32	37.5
5	4	25.0
Total	273	45.4

SHIP'S SERVICEMAN (SH)

LOS	N	% HQ
1	1,716	12.8
2	875	7.9
3	603	5.5
4	539	4.8
5	98	6.1
Total	3,831	9.2

STOREKEEPER (SK)

LOS	N	% HQ
1	2,531	24.8
2	1,719	16.9
3	931	21.8
4	1,122	18.8
5	355	20.8
Total	6.658	21.1

SIGNALMAN (SM)

LOS	N	% HQ
1	1,626	27.3
2	489	27.6
3	219	21.9
4	185	21.1
5	102	18.6
Total	2,621	26.1

SONAR TECHNICIAN (ST)*

LOS	N	% HQ
4	4	50.0
5	24	70.8
Total	28	70.8

Total

SONAR TECHNICIAN--
SURFACE (STG)*

LOS	N	% HQ
1	3,371	72.4
2	362	85.6
3	146	84.9
4	319	79.0
5	47	76.6
Total	4,245	74.5

SONAR TECHNICIAN--
SUBMARINE (STS)*

LOS	N	% HQ
1	2,041	71.4
2	395	84.8
3	105	76.2
4	230	79.1
5	29	69.0
Total	2,800	74.1

STEELWORKER (SW)

LOS	N	% HQ
1	640	25.5
2	152	32.9
3	58	27.6
4	76	31.6
5	8	50.0
Total	934	27.5

TRADEMAN (TD)

LOS	N	% HQ
1	417	64.7
2	432	78.0
3	293	77.8
4	182	85.2
5	48	89.6
Total	1,372	75.3

TORPEDOMAN'S MATE (TM)

LOS	N	% HQ
1	1,605	14.7
2	747	30.0
3	346	55.2
4	385	59.2
5	153	51.0
Total	3,236	29.6

UTILITIESMAN (UT)

LOS	N	% HQ
1	633	22.0
2	264	29.2
3	111	27.0
4	94	33.0
5	29	48.3
Total	1,131	25.7

YEOMAN (YN)

LOS	N	% HQ
1	2,706	21.3
2	1,496	24.7
3	1,093	32.8
4	1,020	36.9
5	390	33.8
Total	6,705	27.0

APPENDIX C

SUPPLY DATA

This appendix is a listing of the logarithms of the 215 observations on the dependent and explanatory variables used in this study.

HSDG	HQ	RELPAY	UNEM	POP	NREC
2.13681	1.38310	-0.217417	2.06686	5.56484	1.57085
2.03014	1.23453	-0.161236	2.16332	5.9584	1.14656
2.25275	1.58807	-0.353313	2.42480	5.46638	1.65001
1.71738	0.795299	-0.220031	2.34181	6.07579	1.01761
2.04067	1.24763	-0.324810	1.80829	5.20284	1.24129
1.93407	1.04083	-0.247993	2.16332	5.61975	1.21221
2.01184	1.01306	-0.205650	2.27213	5.46237	1.38031
1.89094	0.866251	-0.309044	2.06686	5.17638	1.35304
1.57548	0.660304	-0.298606	1.75786	5.22580	1.07865
2.18601	1.43752	-0.434703	1.98787	5.05320	1.34539
1.64140	0.543843	-0.338076	2.04122	5.21190	1.07596
2.15826	1.35714	-0.329472	2.41591	5.28012	1.16719
2.00776	1.01074	-0.264094	1.70475	5.18367	1.26838
1.70591	0.743269	-0.292959	1.90211	5.32052	1.02862
1.66011	0.631396	-0.350327	1.54756	5.68396	0.903588
2.06781	1.28838	-0.115876	1.91692	5.45568	1.62351
2.21221	1.37641	-0.176658	1.94591	5.56768	1.42166
2.22682	1.32018	-0.079435	2.40695	6.00694	1.30227
2.04167	1.20305	-0.123453	1.60944	5.12845	1.50486
1.67868	0.690814	-0.193850	2.10413	5.31800	1.23593
2.09735	1.24837	-0.256283	2.06686	5.27666	1.49069
1.54053	0.488917	-0.329862	1.38629	5.32222	1.11072
1.81439	1.02616	-0.232146	2.06686	5.64840	1.19108
1.79585	0.845974	-0.047795	2.04122	5.84859	1.57558
1.89460	1.11247	-0.143297	1.98787	5.40520	1.40824
1.72217	0.973577	-0.275098	1.90211	5.29174	1.32030
2.06082	1.37909	-0.201530	1.85630	5.29673	1.71087
1.84559	1.14904	-0.193850	2.10413	5.22768	1.25389
1.74031	1.02492	-0.056501	1.60944	5.47787	1.00217
1.90337	1.16270	-0.095330	1.82455	5.29407	1.42736
2.12212	1.12654	-0.220206	2.00148	4.97378	1.38925
1.83760	1.03436	-0.067677	1.48160	5.32866	1.55787
2.04770	1.35530	-0.047795	1.94591	5.15049	1.46290
1.85876	1.01176	-0.098571	1.72277	5.15785	1.27669
1.09368	0.877337	-0.191303	1.60944	5.03346	1.33129
1.49274	0.371404	-0.145724	2.11626	4.94180	1.35346

HSDG	HQ	RELPAY	UNEM	POP	NREC
1.80011	1.07443	-0.270865	2.05412	4.86046	1.46210
1.85194	0.771860	-0.142327	2.04122	5.12254	1.34049
2.18411	1.25977	-0.146048	2.27213	6.04273	1.42293
2.12747	1.41677	-0.1-3165	2.21920	5.35746	1.52601
1.94925	1.21284	-0.229853	2.47654	5.78749	1.20827
2.22513	1.39339	-0.129014	2.45101	6.21647	1.44928
1.75804	1.12917	-0.124404	2.20827	5.52884	1.54189
2.09527	1.29874	-0.192099	2.01490	5.59593	1.53176
1.95783	1.15412	-0.135918	1.91692	5.98949	1.11875
2.14265	1.43400	-0.327996	2.19722	5.49748	1.60420
1.79412	0.695512	-0.194714	2.26176	6.10688	0.933654
1.92846	1.05949	-0.299492	1.62924	5.23393	1.29986
1.90872	0.878583	-0.222675	2.12823	5.65084	1.34585
1.99595	1.09133	-0.180332	2.12823	5.49346	1.40928
2.02092	0.879303	-0.283726	1.87180	5.20747	1.28325
1.59429	0.381464	-0.273288	1.56862	5.25689	1.10441
2.35996	1.45240	-0.409385	1.80829	5.08429	1.47956
1.68555	0.317692	-0.312758	1.77495	5.24299	1.05043
2.17988	1.39809	-0.304154	2.07944	5.31121	1.25827
2.06938	0.979646	-0.238777	1.60944	5.21476	1.25294
1.80924	0.657206	-0.267641	1.48160	5.35161	1.07811
1.63675	0.509506	-0.325009	1.36098	5.71505	0.777187
1.77516	0.905151	-0.090558	1.77495	5.48677	1.59914
2.04184	1.14293	-0.151340	1.77495	5.59877	1.41605
2.1128	1.03693	-0.054117	2.06686	6.03803	1.41263
1.80364	1.04904	-0.098135	1.70475	5.15955	1.48685
1.60841	0.553543	-0.168532	1.68640	5.34909	1.25621
1.86314	0.849233	-0.230965	2.02815	5.30775	1.44686
1.36811	0.363713	-0.304544	1.43508	5.35331	1.07802
1.88319	0.961694	-0.206829	1.56862	5.67949	1.22024
1.58826	0.553262	-0.022478	1.72277	5.87968	1.18849
1.80292	0.926735	-0.117979	1.85630	5.43629	1.48141
1.65724	0.793057	-0.249780	1.74047	5.32283	1.43293
2.05430	1.34421	-0.176212	1.66771	5.32782	1.64009
1.66878	0.941735	-0.168532	1.54756	5.25877	1.37848
1.56176	0.804588	-0.031183	1.62924	5.50896	1.10442
1.75991	1.07011	-0.070013	1.64866	5.32516	1.39144
2.06075	0.994069	-0.194888	2.14007	5.00487	1.39373
1.83992	1.01015	-0.042360	1.41099	5.35975	1.50822
1.88318	1.20024	-0.022478	1.80829	5.18158	1.49172
1.93312	0.953093	-0.073253	1.60944	5.18894	1.28031
1.88818	0.672022	-0.165985	1.50408	5.06455	1.32401
1.55067	0.268854	-0.120406	2.06686	4.97289	1.15398
1.63932	0.676790	-0.245548	1.60944	4.89155	1.44172
1.81050	0.681177	-0.117009	1.94591	5.15363	1.36404
2.11348	1.09245	-0.120730	2.05412	6.07382	1.43771
2.10477	1.36722	-0.107848	2.01490	5.38855	1.42490
1.96214	1.06693	-0.204535	2.32239	5.81858	1.18992
2.15735	1.18905	-0.103696	2.19722	6.24757	1.48041

HSDG	HQ	RELPAY	UNEM	POP	NREC
1.69566	0.899977	-0.099086	2.01490	5.55993	1.54504
1.84263	0.979646	-0.104228	1.80829	5.61613	1.54169
1.67692	0.807039	-0.048046	1.85630	6.00970	1.26401
1.95084	1.21572	-0.240124	2.09186	5.51768	1.65093
1.44026	0.368180	-0.106842	2.11626	6.12709	1.04509
1.80720	1.00545	-0.211621	1.66771	5.25414	1.31265
1.56674	0.539561	-0.134804	1.97408	5.67104	1.53010
1.76359	0.714848	-0.092461	1.96009	5.51366	1.35256
1.86240	0.738472	-0.195854	1.74047	5.22767	1.57619
1.54074	0.256296	-0.185417	1.43508	5.27709	1.20815
2.31668	1.17027	-0.321514	1.75786	5.10450	1.84298
1.67509	0.238066	-0.224887	1.68640	5.26319	1.28382
2.03819	1.24784	-0.216283	1.93152	5.33141	1.55160
1.94129	0.793316	-0.150905	1.58924	5.23496	1.32528
1.39092	0.377584	-0.179769	1.41099	5.37181	1.33054
1.45843	0.302616	-0.237138	1.09861	5.73526	1.02923
1.56969	0.660548	-0.002686	1.60944	5.50697	1.47986
1.71340	0.797764	-0.063468	1.58924	5.61897	1.44319
1.79109	0.801378	-0.033754	1.94591	6.05824	1.39873
1.37419	0.657983	-0.010264	1.64866	5.17975	1.41756
1.34245	0.450790	-0.080661	1.58924	5.36929	1.11772
1.85744	0.874587	-0.143093	1.84055	5.32795	1.35135
1.24121	0.271929	-0.216673	1.30833	5.37352	1.02681
1.71126	0.807587	-0.118957	1.52606	5.69969	1.03903
1.17930	0.280136	0.065394	1.66771	5.89988	1.21551
1.60484	0.687690	-0.030107	1.72277	5.45650	1.45350
1.41040	0.573165	-0.161908	1.52606	5.34304	1.47868
1.51159	0.743284	-0.088341	1.28093	5.34803	1.47496
1.39558	0.623657	-0.080661	1.33500	5.27898	1.20804
1.28208	0.499115	0.056689	1.58924	5.52916	1.10083
1.29973	0.565438	0.017859	1.43508	5.34536	1.03747
1.79276	0.743250	-0.107017	1.77495	5.02507	1.34394
1.61855	0.709088	0.045512	1.38629	5.37996	1.36014
1.56901	0.838476	0.065394	1.66771	5.20178	1.46726
1.72817	0.762115	0.014619	1.41099	5.20915	1.23638
1.69175	0.588570	-0.078114	1.48160	5.08475	1.21000
1.41872	0.253928	-0.032535	1.96009	4.99310	0.929876
1.28061	0.371446	-0.157676	1.19392	4.91176	1.35476
1.42739	0.402113	-0.029138	1.87180	5.17384	1.38640
1.71795	0.781211	-0.032859	1.94591	6.09402	1.36428
1.55255	0.843155	-0.019976	1.62924	5.40875	1.54539
1.70502	0.908801	-0.116663	2.01490	5.83879	1.18072
1.72686	0.821475	-0.015825	1.88707	6.26777	1.22019
1.34251	0.632476	-0.011215	1.70475	5.58013	1.46093
1.67764	0.771612	-0.075039	1.70475	5.63692	1.49084
1.69658	0.774135	-0.018857	1.64866	6.03048	1.32118
1.82609	0.964330	-0.210935	1.94591	5.53846	1.59496
1.31950	0.134399	-0.077653	2.11626	6.14787	0.953989
1.66627	0.779521	-0.182432	1.56862	5.27492	1.22210

HSDG	HQ	RELPAY	UNEM	POP	NREC
1.79086	0.563929	-0.105614	1.94591	5.69182	1.33121
1.76738	0.609741	-0.063272	1.88707	5.53445	1.36328
1.85733	0.603745	-0.166665	1.64866	5.24846	1.61779
1.74703	0.399217	-0.156228	1.41099	5.29788	1.26790
2.26490	1.16999	-0.292325	1.77495	5.12528	2.01752
1.63867	0.067883	-0.195698	1.70475	5.28398	1.37074
2.03117	1.19172	-0.187094	1.82455	5.35220	1.66344
1.91514	0.549390	-0.121716	1.75786	5.25574	1.44791
1.47746	0.400422	-0.150580	1.48160	5.39259	1.32686
1.55585	0.267410	-0.207948	1.13140	5.75604	0.990116
1.47167	0.585931	0.026503	1.56862	5.52775	1.30345
1.35967	0.600525	-0.034279	1.56862	5.63975	1.45528
1.15227	0.571259	0.062943	1.98787	6.07902	1.31198
1.32303	0.441377	0.018926	1.64866	5.20053	1.41229
1.35634	0.267351	-0.051472	1.58924	5.39008	1.16063
1.77333	0.681954	-0.113904	1.75786	5.34873	1.36069
1.23506	0.200411	-0.187483	1.22378	5.39430	1.17479
1.74174	0.748777	-0.089768	1.52606	5.72047	1.22269
0.958692	-0.12157	0.094583	1.62924	5.92066	1.08647
1.45224	0.519174	-0.000918	1.62924	5.47728	1.35519
1.44632	0.581601	-0.132719	1.38629	5.36382	1.38649
1.32946	0.571363	-0.059152	1.09861	5.36881	1.44439
1.22674	0.272395	-0.051472	1.41099	5.29976	1.15917
1.21163	0.333377	0.085878	1.56862	5.54995	1.17377
1.76824	0.979173	0.047048	1.20893	4.71792	1.73731
1.77525	0.750205	-0.077827	1.77495	5.04585	1.29553
1.47759	0.694606	0.074701	1.28093	5.40074	1.38884
1.32279	0.561264	0.094583	1.52606	5.22256	1.42606
1.54999	0.525812	0.043808	1.25276	5.22993	1.20657
1.57783	0.328187	-0.048925	1.54756	5.10554	1.30802
1.62991	0.318841	-0.003345	1.77495	5.01388	1.06784
1.21379	0.185454	-0.128487	1.13140	4.93254	1.31975
1.53041	0.407500	0.000051	1.77495	5.19462	1.31653
1.50492	0.531587	-0.003670	1.75786	6.11480	1.38112
1.72352	1.01619	0.009213	1.66771	5.42953	1.55709
1.36591	0.550607	-0.087474	1.79176	5.85957	1.31355
1.54346	0.535823	0.013364	1.70475	6.28855	1.32821
1.27535	0.570788	0.017975	1.64866	5.60091	1.40835
1.86552	1.00176	-0.75039	1.79176	5.64180	1.48348
1.83838	0.953327	-0.018857	1.60944	6.03537	1.43372
2.03052	1.24663	-0.210935	2.24071	5.54335	1.66821
1.58155	0.534119	-0.077653	2.06686	6.15275	1.01814
1.94352	1.02839	-0.182432	1.74047	5.27980	1.40606
1.90513	0.826477	-0.105614	1.94591	5.69671	1.43579
1.93057	0.808682	-0.063272	1.94591	5.53933	1.50470
2.04531	0.990960	-0.166665	1.66771	5.25334	1.64031
1.87460	0.766206	-0.156228	1.45862	5.30276	1.23538
2.36602	1.35810	-0.292325	1.70475	5.13016	2.02991
1.78880	0.478404	-0.195698	1.77495	5.28886	1.36658
2.09264	1.33111	-0.187094	1.74047	5.35708	1.59660

HSDG	HQ	RELPAY	UNEM	POP	NREC
1.98112	0.954382	-0.121716	1.88707	5.26063	1.51016
1.81181	0.897087	-0.150580	1.66771	5.39748	1.43340
1.66504	0.554981	-0.207948	1.43508	5.76092	1.11431
1.95466	0.977988	0.026503	1.91692	5.53264	1.36608
1.95932	1.02082	-0.034279	1.68640	5.64464	1.44794
1.98295	1.03587	0.062943	2.46810	6.08391	1.31610
1.83853	0.992465	0.018926	1.97408	5.20542	1.55616
1.65637	0.607993	-0.051472	1.94591	5.39496	1.24622
1.97476	0.966119	-0.113904	1.96009	5.35362	1.52574
1.52477	0.642383	-0.187483	1.25276	5.39919	1.30278
1.95501	1.04532	-0.089770	1.43508	5.72536	1.27952
1.54314	0.538179	0.094583	1.96009	5.92555	1.22985
1.86965	0.860257	-0.000918	2.02815	5.48216	1.42158
1.70716	0.856867	-0.132719	1.74047	5.36871	1.39749
1.59221	0.853977	-0.059152	1.48160	5.37369	1.50257
1.54223	0.713934	-0.051472	1.62924	5.30464	1.44412
1.78740	0.941473	0.085878	2.02815	5.55483	1.45186
1.37499	0.652707	0.047048	1.68640	5.37103	1.13923
1.92811	0.962659	-0.077827	2.01490	5.05074	1.52851
1.72610	0.839678	0.074701	1.43508	5.40563	1.34548
1.82480	1.07103	0.094583	1.54756	5.22748	2.17987
1.80448	0.839054	0.043808	1.36098	5.23482	1.49859
1.81875	0.769816	-0.048925	1.60944	5.11042	1.52421
1.55906	0.388398	-0.003345	1.84055	5.01876	1.18377
1.41430	0.435935	-0.128487	1.25276	4.93743	1.29109
1.71289	0.647547	0.000051	1.82455	5.19950	1.38529
1.86815	0.855196	-0.003670	1.79176	6.11969	1.40433
1.98010	1.33991	0.009213	1.75786	5.43442	1.60524
1.72349	0.945632	-0.087474	1.88707	5.86445	1.25841
1.75526	0.786909	0.013364	1.68640	6.29344	1.45027
1.50967	0.824257	0.017974	1.79176	5.60580	1.41081

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