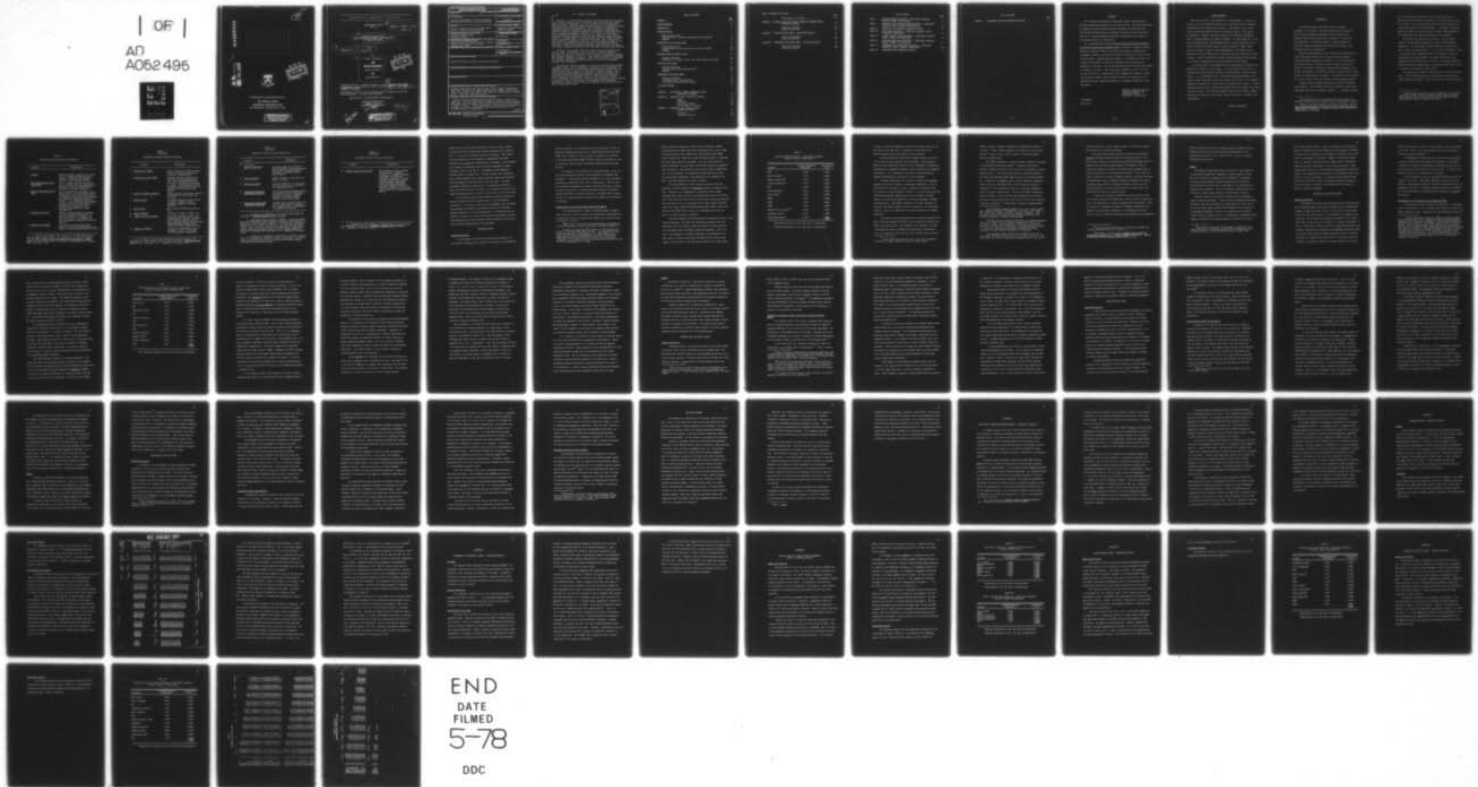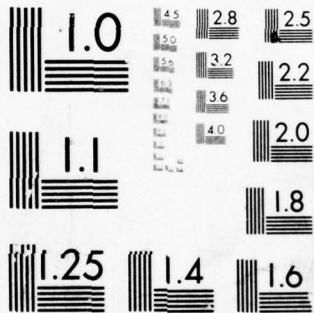AD-A052 495   WHARTON SCHOOL PHILADELPHIA PA INDUSTRIAL RESEARCH UNIT   F/G 5/9
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A STATISTICAL ANALYSIS OF
MINORITY PERSONNEL UPGRADING OPPORTUNITIES
IN THE ENLISTED NAVY

Technical rept.,

by

Steven M. DiAntonio

Contributing Authors

George O. Boomer

and

Adolfo Castilla

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

> This statistical analysis was conducted in order to accomplish two objectives. The first objective was to model the Naval enlisted personnel advancement functions based on both personal characteristics and inservice variables. Second, and more importantly, the analysis evaluates minority vs. majority personnel advancement opportunities with respect to the variables found to be significant.

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Initially, a promotion model was constructed using preservice information such as marital status, region of residence, mental aptitude exam scores, years of education completed, age, etc. One objective of the preservice model was to make race-ethnic group comparisons based on information collected at enlistment and shortly thereafter. Next, the model was expanded by combining preservice information with data on inservice characteristics. Inservice variables included occupational classification, discipline record, time in the Navy, performance evaluation, etc. Again, the race-ethnic group profiles were compared but this time with respect to these inservice variables. The preservice plus inservice model was later refined to include separate race-ethnic models, a cross-sectional model, and a model derived from personnel in paygrades E5 and above. The above models provided for the evaluation of advancement functions constructed from disparate samples. Additional insight was provided through model comparisons where the sample time frames, paygrade distributions, and race-ethnic categories were different.

Generally, the variables found to be significant are consistent from model to model. Exceptions to this were noted. "Academic credential" variables are found to be important and to influence an individual's advancement potential throughout his career. These variable frequency distributions are strikingly different for majority, black, and "other" minority personnel. The "academic credential" variables account for much of the race-ethnic promotion rate differences.

The following inservice variables are found to be statistically related to paygrade level: time in the service, discipline record, leadership and appearance evaluations, and occupational classification. These factors are extremely important in terms of an individual's promotion success. The relative impact of these variables on minority vs. majority personnel was evaluated. Minority personnel are adversely affected by the influence of these variables on the advancement function. The statistical analysis not only identified factors which strongly influence promotion but also measured the relative impact of these factors on race-ethnic group advancement opportunities. Those variables which are regulated by institutional policy were of particular interest.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

FOREWORD

This statistical analysis was conducted in order to study minority personnel upgrading opportunities in the enlisted Navy. This was accomplished by modeling the Naval enlisted personnel advancement functions based on both personal characteristics and inservice variables, and then evaluating minority vs. majority personnel advancement opportunities with respect to the variables found to be significant.

In a forthcoming book entitled <u>Black and Other Minority Participation in the All-Volunteer Navy and Marine Corps</u>, by Herbert R. Northrup, Steven M. DiAntonio, and Dale F. Daniel, the services occupational classification, assignment, promotion, and retention systems are evaluated in terms of their current ability to upgrade minority personnel. The question of whether the services' institutional policies and affirmative action objectives are compatible is evaluated. The conclusions derived from the statistical analysis are helpful in two ways. First, the analysis answers, in part, the above affirmative action vs. institutional policy compatibility question. Second, the statistical results provide insight into what the effects will be of modifying the policy regulated variables to accommodate affirmative action objectives.

Herbert R. Northrup, Director
Industrial Research Unit
The Wharton School
University of Pennsylvania

Philadelphia

July 1977

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INTRODUCTION

A statistical analysis has been conducted in order to accomplish two objectives. The first objective was to model the Naval enlisted personnel advancement functions based on both personal characteristics and inservice variables.[1] Second, and more importantly, the analysis sought to evaluate minority vs. majority personnel advancement opportunities with respect to the variables found to be significant.

This study draws attention to the variables which define the enlisted advancement function and which have an adverse impact on minority personnel upgrading opportunities. In a forthcoming book authored by Herbert R. Northrup, Steven M. DiAntonio, and Dale F. Daniel,[2] the services occupational classification, assignment, promotion, and retention systems are evaluated in terms of their current ability to upgrade minority personnel. The results of this evaluation are derived, in part, from the statistical results discussed below.

Stepwise multiple regressions were used to model the advancement functions. The variables which were considered to enter these advancement functions are defined in Figure 1. Frequency distribu-

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[1] The variables used in the analysis were those thought to be important and which could be obtained from the Department of Defense.

[2] Herbert R. Northrup, Steven M. DiAntonio, and Dale F. Daniel, Black and Other Minority Participation in the All-Volunteer Navy and Marine Corps (Philadelphia: Industrial Research Unit, University of Pennsylvania), forthcoming.

1

tion and correlation analyses were used to compare minority vs. majority personnel profiles with respect to the significant variables in the models. Model interpretations based on these regression and correlation analyses are discussed shortly. Information concerning model construction and bias, statistical results, and methodology is not presented her but rather is discussed in the appendices.

The analysis was conducted in two phases. The first phase modeled the Navy enlisted advancement function using preservice information. The second phase combined preservice information with data on inserivce characteristics. It is of value of the Navy to look at race-ethnic group comparisons based on information collected at enlistement and shorly thereafter, and again when inservice performance and occupational data are available. Both models generated their results from a common sample of individuals whose range of time in the Navy is two months to fifteen years.

The preservice plus inservice model was later refined in several ways. First, separate models were constructed for blacks and for "other" minority personnel.[3] The black and "other" minority personnel

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[3]"Other" minority personnel consist of members of the following race-ethnic groups: Caucasian, Spanish descent; American Indian; Asian American; Puerto Rican; Filipino; Mexican American; Eskimo; Cuban American; Chinese; Japanese; and Korean.

Figure 1

Advancement Function Variable Definitions

Variable	Description
1. <u>Paygrade</u>	Member's paygrade (rank) as of June 1975. E1 is the lowest paygrade; E9 is the highest. Paygrade is the dependent variable in the regression models.
2. <u>Armed Forces Qualification Test (AFQT)</u>	AFQT is a mental aptitude test which, until 1 January 1976, was administered to personnel at the recruiting station to determine enlistment eligibility.
3. <u>General Classification Test (GCT)</u>	One of six sections of the Basic Test Battery (BTB).[a] The GCT measures verbal comprehension which entails the ability to understand written and spoken language, thus indirectly measuring reasoning ability. It is represented most heavily in what is often termed as reading skill. Vocabulary is only a factor which characterizes reading skill; but it provides a good measure of verbal comprehension.
4. <u>Arithmetic Test (ARI)</u>	Designed to measure general reasoning, it is concerned with the ability to generate solutions to problems. ARI tests the ability to use numbers and apply mathematical reasoning in practical problems.
5. <u>Mechanical Test (MECH)</u>	Tests aptitude for mechanical work, mechanical and electrical knowledge, and ability to understand mechanical principles.

a. The Basic Test Battery (BTB) consists of the following sections: GCT, ARI, MECH, CLER, and SHOP. The definitions are taken from Bureau of Naval Personnel, <u>Manual of Enlisted Classification Procedures, Navpers 15812</u>, and BUPERS NOTICE 1236 of 3 March 1976 (Washington, D.C.: Department of the Navy, 1976).

Figure 1
(Continued)

Advancement Function Variable Definitions

Variable	Description
6. Clerical Test (CLER)	Tests the ability to observe details rapidly and measures the speed of responses to observations.
7. Shop Practice Test (SHOP)	Measures functional ability of an individual who has had experience with, and is knowledgeable about, the use of a variety of tools found in a shop. The experience with and knowledge of shop practices might be acquired from high school shop courses.
8. Years of education completed	Number of years of education completed by a member for which credit was received.
9. Marital status	Individual designated either married or single, divorced, legally separated, widowed, or marriage annulled.
10. Age at entry	Age at which individual entered the Navy.
11. Black personnel	Individual is member of Negro race.
12. "Other" minority personnel	Individual is member of one of the following ethnic groups;[b] Caucasian, Spanish descent; American Indian; Asian American; Puerto Rican; Filipino; Mexican American; Eskimo; Cuban American; Chinese; Japanese; Korean.
13. Region of residence	Indicates an individual's official residence at time of enlistment. The United States is broken down

b. The "other" minority group designations are those used by the Department of Defense reference Bureau of Naval Personnel, COMNAVCRUITCOMINST 1130.8 series (Washington, D.C.: Department of the Navy, n.d.).

Figure 1
(Continued)

Advancement Function Variable Definitions

Variable	Description
13. (continued) Region of residence	into eight regions as follows:[c] Central Atlantic, Pacific, Southeast, Great Lakes, Southwest, Midwest, Northeast, and Non-Continental United States.
14. Time in service	Number of months an individual has been in the Navy.
15. Discipline record	Indicates whether or not individual has been disciplined to the extent of a reduction in rate.
16. Occupations with open advancement potential[d]	Includes those ratings which provide the greatest amount of advancement opportunity because of manpower shortages in the petty officer enlisted rates (E4 and above).
17. Occupations with closed advancement potential[e]	Includes those occupations which provide the least amount of advancement opportunity due to overmanning in paygrades E4 and above.

c. The state, U.S. possession, and foreign country codes are referenced in COMNAVCRUITCOMINST 1130.8, op. cit.

d. Career Reenlistment Objectives (CREO) is a personnel management system designed to match manpower requirements and advancement opportunity with occupational categories. The three CREO occupational categories are as follows: Open Rating, Neutral Rating, and Closed Rating. Navy ratings (occupations) are broken down into CREO occupational categories in Bureau of Naval Personnel, BUPERS INSTRUCTION 1133.25C of 3 December 1975 (Washington, D.C.: Department of the Navy, 1975).

e. Personnel not assigned to either open or closed occupations must be, by elimination, assigned to neutral occupations. The Neutral Rating occupations represent an approximate match between manpower requirements and personnel manning.

Figure 1
(Continued)

Advancement Function Variable Definitions

Variable	Description
18. Current evaluation variables[f]	The following variables provide information on a command's evaluation of a member's personal performance and abilities: performance, appearance, cooperativeness, reliability, conduct, resourcefulness, leadership, overall and equal opportunity evaluation (member's ability to deal with individuals of all race-ethnic groups in a nondiscriminatory manner).

f. Variables are fully defined in references Bureau of Naval Personnel, BUPERSNOTE 1616 series and <u>BUPERSMAN, NAVPERS 15791</u> (Washington, D.C.: Department of the Navy, n.d.).

samples used for these models were derived from the original sample.
The second refinement expanded the original preservice plus inservice
model to include the performance evaluation variables. This informa-
tion was available only for personnel in paygrades E5 and above.
Therefore, a new sample was constructed for this model. To be included
in the sample, an individual must have been E5 paygrade or higher.
The range of time in the Navy by the members of this sample was
thirteen months to sixteen years. The above models were constructed
from a single snapshot of the sample personnel, rather than from more
than one snapshot of each individual taken over time. The final
refinement involved the construction of a cross-sectional model in
order to control for time in the Navy. All personnel included in this
sample had approximately four years of active duty as of the file date.

The statistical analysis was designed to evaluate minority vs.
majority personnel promotion opportunities in the enlisted Navy
environment. As can be seen from the above paragraph, this evaluation
was conducted for different time frames as well as for different
paygrade segments of the enlisted population. Interpretation of the
models with respect to locating the significant advancement variables
and determining the relative impact of these variables on race-ethnic
group promotion opportunities is now discussed.

PRESERVICE MODEL

Research Objectives

An advancement function was constructed from personal and
environmental characteristics compiled on personnel at enlistment and

shortly thereafter. The variables which were considered to enter the preservice advancement function are: Armed Forces Qualification Test (AFQT) score,[4] number of years of education completed, all subtests of the Basic Test Battery (BTB),[5] official region of residence at time of enlistment, marital status, race-ethnic characteristics, and age at entry.

One objective of this model was to determine which, if any, of the above variables contribute to the explanation of paygrade level attainment. Of particular interest was whether or not the race-ethnic variables are significant and, if so, to what extent. That is, when the contributing explanatory variables other than race-ethnic information are held constant, do minority personnel advance as quickly as majority personnel? The second objective of the model was to compare minority vs. majority personnel profiles with respect to the variables in the model.

Interpretation of Preservice Model Statistical Results

The following factors, listed in descending order of significance, are found to have a statistically significant relationship with the dependent variable: Arithmetic Test (ARI) score, marital status,

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[4] AFQT, until 1 January 1976, was administered to personnel at the recruiting station in order to determine enlistment eligibility.

[5] The Basic Test Battery (BTB) consists of the following subsections: GCT, ARI, MECH, CLER, and SHOP. An individual's occupational classification is determined by, to a large extent, that individual's composite score obtained on the BTB. The series of exams comprising the BTB ostensibly combine to provide accurate information on an individual's mental aptitude and vocational aptitude. The BTB is administered at boot camp.

years of education completed, "other" minority personnel, General

Classification Test (GCT) score, black personnel, age at entry, Armed

Forces Qualification Test (AFQT) score, Shop Practice Test (SHOP)

score, Clerical Test (CLER) score, and the Central Atlantic, Southeast,

and Great Lakes regions of residence. The first five factors are

highly significant, and each shows a strong relationship with paygrade

level attainment. Black personnel, age at entry, AFQT, and SHOP show

less of a relationship. The remaining variables each have a weak,

but statistically significant, relationship with the dependent vari-

able. The model statistics are shown in Table 1.

With the exception of "other" minority personnel and black

personnel, the above factors are positively related to paygrade attain-

ment. Therefore, in the aggregate, an individual with a higher

Arithmetic Test (ARI) score will be promoted faster than an individual

with a lower ARI score when all other significant factors are identical.

The same holds true for an individual with a higher General Classifi-

cation Test (GCT), Armed Forces Qualification Test (AFQT), and/or Shop

Practice Test (SHOP) score as well as an individual who enters the

Navy at an older age and/or is married.

Generally speaking, minority personnel are promoted more slowly than

majority personnel. Even when the significant variables other than

race-ethnic are held constant, blacks and "other" minority personnel

are not promoted quite as quickly as majority personnel. That is to

say, in the aggregate, a minority individual is not promoted at the

same rate as a majority individual, although both are from the same

region, enter the Navy at the same time and age, have the same number

Table 1

Preservice Model Statistics: Significant Variables
Listed in Order of Significance

Variable	Standard Regression Coefficient	Contribution to R^2
ARI[a]	0.234	0.3279
Marital status[a]	0.370	0.1492
Years of education[a]	0.189	0.0250
"Other" minorities[a]	-0.107	0.0100
GCT[a]	0.102	0.0091
Black personnel[a]	-0.075	0.0047
Age of entry[a]	0.056	0.0022
AFQT[a]	0.103	0.0021
Shop[a]	0.063	0.0029
CLER[a]	0.032	0.0008
Central Atlantic region[b]	0.023	0.0006
Southeast region[b]	-0.026	0.0006
Great Lakes region[b]	-0.022	0.0005
		.5357

[a]Variable significant at the .005 level of significance.

[b]Variable significant at the .025 level of significance.

of years of education completed, and receive equivalent scores on the
BTB exams and the AFQT exam. In addition, black personnel are
promoted slightly faster than "other" minority personnel.

The above preservice significant variables account for much of
the race-ethnic group promotion rate differences. Those variables
which are also inextricably tied to a policy framework in occupational
classification, assignment, promotion, and/or retention are of particu-
lar interest. It is important to determine to what extent group
promotion differences are explained by these variables.

"Academic credentials," as a whole, are found to be extremely
important factors with respect to advancement opportunity. ARI and
GCT scores[6] and the number of years of education completed are the
most important of the "academic" variables. It can be safely said that
individuals possessing capabilities which are measured by higher
scores on the ARI and GCT exams have a distinct advantage in advance-
ment opportunity. CLER, MECH, and SHOP are the least important of
the Basic Test Battery exams in terms of influence on the advancement
function. MECH is not significant and CLER and SHOP are only weakly
significant.

The dominant factors determining Navy enlistment eligibility are
mental aptitude (measured by either a short version of the BTB or the
AFQT) and education level. The composite score obtained on the BTB
is the dominant factor in determining occupational classification.
It is not surprising, then, that ARI, GCT, and AFQT scores as well as

_____

[6] The ARI and GCT examinations are the most heavily weighted
sections of the BTB in terms of occupation classification.

number of years of education completed are significant variables in the model.[7] These "academic credential" variables will now be evaluated with respect to their relative impact on minority personnel promotion opportunities.

Only small differences in number of years of education completed are found between race-ethnic groups.[8] Therefore, the years of education variable accounts for very little of the difference in group promotion rates. On the other hand, there are large differences in the mental aptitude exam scores between majority and minority personnel. Speaking in an aggregate sense, minority personnel, especially blacks, have much lower AFQT, GCT, and ARI scores than majority personnel.[9] These variables are found to be extremely important in terms of promotion opportunities. The fact that these variables are heavily weighted, coupled with the large differences in race-ethnic group mean scores, provide much of the reason for the slower promotion of minority personnel. In other words, the heavily weighted mental

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[7] The correlation between paygrade level and the highly significant "academic credential" variables are as follows: GCT, .5226; ARI, .5742; AFQT, .5228; and years of education completed, .4562. It is clear from these correlations that "academic credentials" are extremely important in terms of being advanced.

[8] The mean years of education completed for the aggregate sample, blacks, and "other" minority personnel, respectively, are: 11.8, 11.5 and 11.2 years. The proportion of variation of the years of education variable which is explained by the black personnel variable is .6 percent. The proportion of years of education variation explained by "other" minority personnel is 2.2 percent.

[9] The aggregate sample means scores for AFQT, GCT and ARI, in that order, are 64 (s.d. 21), 56 (s.d. 9.7), and 53.6 (s.d. 9). The mean scores for blacks on these same examinations are 43, 46, and 44.7.

aptitude exams have a severe negative impact on the relative advancement opportunity of minority personnel.

The above results might lead one to question the educational quality differences between minority and majority personnel. The model results indicate a strong positive relationship between years of education and the mental aptitude exams.[10] Furthermore, there is additional evidence to support the contention that education level is highly correlated with so-called mental aptitude.[11] Given that the years of education of minority personnel relative to majority personnel are approximately equal, perhaps the quality of education of minority personnel, again relative to majority personnel, accounts for the group differences in aptitude scores as well as a great deal of the variation with respect to promotion rates.

If quality of education differences account for much of race-ethnic group promotion rate disparities, then the Navy can choose from one of two alternatives in order to upgrade minority personnel. First, the service can downgrade the weight of "academic credentials" with respect to their relative importance in the advancement function. This is one way to decrease race-ethnic group promotion rate differences.

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[10] The correlations between years of education and AFQT, GCT, and ARI respectively are .42, .50, and .49.

[11] See Arthur I. Siegel, et al., Nonverbal and Culture Fair Performance Procedures II. Initial Validation (Wayne, Pa.: Applied Psychological Services Science Center, 1974), pp. 2-3.

Secondly, the Navy can provide a remedial education program for those having potential but who are educationally disadvantaged. Such a program would certainly have a positive effect on minority personnel advancement opportunities.

Summary

The preservice advancement model is a good one. The combination of statistically significant independent variables explains a great deal of the variation in paygrade level attainment.[12] Furthermore, the model provides insight into which personal and environmental characteristics contribute, and to what extent, to the explanation of paygrade level attainment. The policy regulated variables were each evaluated in terms of their impact on the race-ethnic variables.

The model indicated that minority personnel are not promoted as quickly as majority personnel. However, when the preservice significant variables, other than race-ethnic, are held fixed, much, but not all, of the race-ethnic group promotion rate differences are accounted for. The remaining differences in minority vs. majority and in black vs. "other" minority promotion rates (i.e., differences in advancement after preservice variables are controlled) must be accounted for by one or

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[12]The multiple correlation (R^2) measures the proportion of the total variation of the dependent variable which is explained by the regression equation. For the preservice model, R^2 equals .5357.

both of two possible reasons. First, the promotion rate differences might be accounted for by other personal and environmental characteristics which are not compiled on an individual at enlistment and, therefore, not considered in this model. Examples of additional factors which, if measured, might provide more insight into an individual's promotion potential are motivation and vocational interest. These factors might also help to further explain group promotion differences. Finally, the unexplained group promotion rate differences might be the result of inservice phenomena. The inservice plus preservice model will now be evaluated in order to determine the specific reasons as well as the extent of promotion rate differences which occur as a result of inservice phenomena.

PRESERVICE PLUS INSERVICE MODEL

Research Objectives

One reason for constructing the preservice plus inservice model was to determine whether additional information such as occupational category, discipline record, time in the Navy, and on-the-job evaluations add, and to what extent, to the explanation of paygrade level attainment. Do the significant preservice variables of the initial model remain significant with the addition of inservice variables? It will be interesting to determine the mix of significant preservice and inservice variables which constitute the advancement opportunity model. Do the race-ethnic variables remain significant after the inservice variables are introduced and controlled for? The second reason for enlarging the preservice model was to compare minority vs. majority

personnel profiles with respect to the significant inservice variables in the model. What is the relative impact of the above variables on minority personnel advancement?

The independent variables that were initially being considered to enter the preservice model remained as candidates in this model. In addition, occupational classification, discipline record, and time in the Navy were also considered to enter the model. As before, pay-grades E1 through E7 are represented in the sample.

Neither advancement exams nor performance evaluations were considered in this model. Advancement examination scores could not be obtained, and performance evaluation information was available only for paygrades E5 and above. Performance evaluation scores are considered in a later model where the sample consists of personnel in paygrades E5 and above.

Interpretation of the Preservice plus Inservice Model

The following factors are found to be significant in decreasing order of significance: time in the Navy, ARI, discipline record, GCT, years of education, AFQT, occupations with open advancement potential,[13]

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[13] Career Reenlistment Objectives (CREO) is a personnel management system designed to match manpower requirements and advancement opportunity with occupational categories. The three CREO occupational categories are as follows: Open Rating, Neutral Rating, and Closed Rating. The Open Rating category (fast promotion rate occupations) includes those occupations which provide the greatest amount of advancement opportunity because of manpower shortages in the petty officer enlisted rates (E4 and above). The Closed Rating category (slow promotion rate occupations) includes those occupations which provide the least amount of advancement opportunity due to overmanning in paygrades E4 and above.

CLER, occupations with closed advancement potential, marital status, "other" minority personnel, and SHOP. The first five variables are highly significant and contribute substantially to the explanation of the dependent variable variance. They account for 97 percent of the multiple correlation of the model. The remaining variables are statistically significant but display a much weaker relationship with the dependent variable, relatively speaking. All factors are positively related to paygrade level with the exception of discipline record, closed advancement opportunity occupations, and "other" minority personnel. These factors are negatively related to the dependent variable. The model statistics are shown in Table 2.

The following preservice variables continue to demonstrate a statistically significant relationship with the dependent variable despite the incorporation of inservice variables: ARI, GCT, years of education, AFQT, CLER, marital status, "other" minority personnel, and SHOP. These variables continue to impact upon an individual during the course of an enlistment. Note that the majority of "academic credential" variables remain significant. The relative impact of these variables on minority personnel promotion rates were determined in the preservice model discussion.

The black personnel variable is no longer significant. This means that blacks are promoted as quickly as members of the majority when the significant preservice plus inservice variables are held fixed. So, for a given black and majority member with identical "academic credentials," occupation classification, discipline record, and time in the Navy, there will be no difference in promotion rates between

Table 2

Preservice Plus Inservice Model Statistics: Significant
Variables Listed in Order of Significance

Variable[a]	Standard Regression Coefficient	Contribution to R^2
Time in Navy	0.666	0.6853
ARI	0.104	0.0718
Discipline record	-0.139	0.0208
GCT	0.072	0.0101
Years of education	0.084	0.0055
AFQT	0.075	0.0036
Open occupations	0.040	0.0026
CLER	0.044	0.0016
Closed occupations	0.040	0.0014
Marital status	0.043	0.0013
"Other" minorities	-0.036	0.0012
SHOP	0.031	0.0007
		.8059

[a]All variables significant at the .005 level of significance.

the two individuals. This does not mean that black personnel, in general, are promoted as quickly as majority personnel. In fact, the preservice model results clearly state otherwise. Yet, as stated, the results of this model show that a black individual and a majority individual, with _identical_ preservice and inservice variable characteristics, will advance at the same rate. Since the black and majority personnel populations _are not identical_, the important question becomes: Which of the statistically significant variables account for the promotion rate disparities? This question will be further examined shortly.

The "other" minority personnel variable remains significant in the preservice plus inservice model. Thus, "other" minority personnel are promoted slightly slower than majority personnel (and blacks) when the significant variables are held fixed. That is, in the aggregate, given an individual who is classified as an "other" minority and an individual who is a member of the majority, with equivalent time in the Navy, "academic credentials," marital status, discipline record, and occupational classification, the majority member will be promoted faster than the "other" minority member. However, the "other" minority personnel factor has a much weaker relationship with paygrade level when the inservice variables are included in the model. It will be interesting to see whether incorporating the current evaluation data into the (E5 and above) model will account for the remaining difference in promotion rates.

In the preservice model, black personnel and "other" minority personnel were found not to have achieved as high a paygrade level as

majority personnel. With the addition of the inservice variables into the model, however, black personnel is no longer a significant variable, and the difference between "other" minority personnel and majority personnel promotion rates, when the significant variables are controlled for, has been reduced. Therefore, when variables which measure inservice phenomena are included in the model and when the differential promotion rate evaluations are made based on identical race-ethnic group scores for these variables, blacks are found to be promoted at the same rate as majority personnel, and "other" minority personnel are found to be promoted at a slightly slower rate.

The combination of inservice plus preservice variables completely explains the advancement rate differences between black and majority personnel and goes a long way towards explaining the differences between "other" minority personnel and majority personnel. Hopefully, the models which are yet to be investigated will identify additional variables which explain the remaining difference in "other" minority vs. majority personnel promotion rates. All of the inservice variables which were considered to enter the model are found to be statistically significant. The relative impact of these inservice variables on minority personnel will now be examined.

In the aggregate, an individual with more time in the Navy will have a higher paygrade than an individual with less. The range of time in the Navy for members of the sample used to generate both this model and the preservice model is two months to fifteen years. The frequency distribution of time in service by race-ethnic group provides

interesting results. For example, 28 percent of the aggregate sample or somewhat less than that for majority personnel has lengths of service, as of the file date, of less than or equal to twelve months. However, approximately 50 percent of the minority personnel in the sample have equivalent lengths of service. Generally speaking, minority personnel in the sample have less time in the Navy than majority personnel. As already stated, time in the Navy has a very strong positive relationship with paygrade level attainment. Certainly the differences in race-ethnic group average lengths of Naval service account for much of the difference in race-ethnic group average paygrade levels. More will be said about the distribution of time in the Navy for minority personnel later.

From the model, it is evident that the decision as to whether or not an individual is advanced depends, to a large extent, on his disciplinary record. The percentage of the sample reduced in paygrade because of disciplinary actions is 2.5. The percentages of black personnel and "other" minority personnel who have been reduced in paygrade are 5.3 and 3.3 respectively. Thus, the percentages of blacks and "other" minority personnel who have been reduced in paygrade exceed the aggregate sample percentage. Because disciplinary action is a factor which is strongly related to paygrade level, the impact on minority advancement of more than proportionate "busts" is severe.

Open advancement opportunity occupations and closed advancement opportunity occupations are statistically significant variables. Occupational classification, therefore, does make a difference in terms of an individual's promotion rate. Individuals assigned to the so-called open occupational ratings are promoted slightly faster than individuals assigned to the neutral occupational ratings, all else being equal. In turn, the neutral ratings are promoted slightly faster than the closed ratings. In the sample, 42 percent of the personnel are assigned to an open rating, 50 percent to a neutral rating, and 8 percent to a closed rating. Concerning black personnel in the sample, approximately 27 percent are assigned to open ratings, 70 percent to neutral ratings, and approximately 2 percent to closed ratings. With respect to the "other" minority personnel, 41.8 percent are assigned to open ratings, 51.6 percent to neutral ratings, and 6.6 percent to closed ratings.

It is difficult to evaluate the overall impact on minority personnel of the above distribution of occupational classification. Blacks are severely underrepresented in the occupations with the greatest advancement potential. Black personnel are also underrepresented in the slowest advancement categories but overrepresented in the neutral advancement track. The net conclusion is that blacks are not proportionately distributed across occupations nor as well off in terms of advancement opportunity relative to majority personnel as a result of this distribution. "Other" minority personnel are distributed approximately proportionately across advancement opportunity job tracks.

Summary

The model is a good one. The multiple correlation increases
substantially as a result of considering the inservice variables for
entry into the model.[14] Through identifying variables, both preservice
and inservice, which constitute a good advancement function, the reasons
why the minority personnel enlisted population is promoted slower than
the majority personnel population were investigated.

"Academic credentials," occupational classification, time in
service, and discipline record are jointly found to be strongly related
with the enlisted advancement function. Correlation and frequency
distribution analyses clearly indicate that minority personnel are
adversely affected, in relative terms, by the strong influence of these
variables on paygrade level attainment. The extent to which each of
the above variables has an adverse relative impact on minority personnel
promotion rates was ascertained in the preceding pages.

SEPARATE BLACK AND ETHNIC MODELS

Research Objectives

Separate preservice plus inservice models for both black person-
nel and for "other" minority personnel will be evaluated next. The
black model will provide insight into the advancement opportunity func-
tion for black personnel. The ethnic model will do the same for "other"
minority personnel. Comparisons will be made between the two race-

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[14]The multiple correlation (R^2) measures the proportion of the
total variation of the dependent variable which is explained by the
regression equation. For the preservice plus inservice model, R^2 equals
.8058.

ethnic models as well as between these two minority personnel models and the aggregate model.

Separate models for both black and ethnic members were derived from the original sample. The black subsample consists of the 524 blacks in the sample, and the ethnic subsample consists of the 390 "other" minority personnel in the sample.[15] The explanatory variables that were considered to enter the original preservice plus inservice model remained as candidates in these models with the exception, of course, of the race-ethnic variables.

Comparison of Original, Black, and "Other" Minority Personnel Models

The variables found in the original preservice plus inservice model to influence promotion rates essentially remain the same when separate models are run for black and "other" minority personnel. The exceptions to this statement will be discussed. Although many of the influential variables are the same, the degree of variable significance for the separate models is less than that of the original model.[16]

In the black model, the following variables are found to be significant, in decreasing order of significance:[17] time in the Navy,

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[15] From the Bureau of Naval Personnel master enlisted file tape, a random sample of 5,000 cases (individuals) were extracted. Minority personnel are well represented in this sample (i.e., 10.6 percent black personnel and 7.8 percent "other" minority personnel).

[16] R^2 for the black regression equation is .7471 and for the final "other" minority personnel equation .5289. R^2 for the original model is .8058. An explanation of the differences in the value of multiple correlation between the black, "other" minority, and original models is presented in Appendix D.

[17] The black and "other" minority model statistics are found in Appendix D (Tables D-1 and D-2 respectively).

discipline record, AFQT, years of education completed, SHOP, marital status, GCT, and open advancement opportunity occupations. In the "other" minority model, the following variables, also listed in decreasing order of significance, are statistically related to paygrade: time in the Navy, AFQT, discipline record, years of education, closed advancement opportunity occupations, and ARI. The first three of these variables account for 95 percent of model multiple correlation. With respect to the black personnel model results, the first four variables strongly influence promotion and together account for 97 per- cent of model multiple correlation. The remaining variables each account for a relatively weak but statistically significant relation- ship with paygrade level.

Concerning the inservice variables, the original model results indicate that time in the service and discipline record are most strongly related to paygrade. The occupational classification vari- ables were each found to display a much weaker relationship with the dependent variable. In the separate race-ethnic models, time in the service and discipline record remain the most influential inservice variables. However, whereas both occupational classification variables were found to be significant in the original model, only open occupa- tion in the black model and only closed occupation in the "other" minority model remain significant.

With respect to the preservice variables, recall that the results of the original model indicated that the joint significance of the BTB exams, AFQT exam, and years of education completed is great. These "academic credential" variables were found to contribute,

in large part, to the explanation of paygrade level variation. Of the "academic credential" variables, ARI and GCT are the two which displayed the strongest relationship with the dependent variable.

When separate models are run for black personnel and for "other" minority personnel of the sample, the joint significance of the "academic credential" variables is not found to be as important. In both models, the AFQT exam is found to show the strongest relationship with paygrade level. In the black model, GCT is the only other statistically significant exam variable, and, in the "other" minority model, ARI is the only other significant exam variable. Both GCT, for blacks, and ARI, for "other" minority personnel, display relatively weak relationships with the dependent variable.

It is concluded that black and "other" minority personnel promotion rates are determined, to a greater extent, by AFQT exam scores than by BTB exam scores. This phenomenon is contrasted with the original model where GCT and ARI are strongly influential and AFQT less so. A possible explanation for the above difference in model results is presented next.

A certain percentage of new recruits is guaranteed an occupational classification at enlistment. Until recently, the selection criterion for this guaranteed formal school assignment was the AFQT exam. Normally, however, selection for formal school training was determined by the BTB exams, especially the GCT and ARI subtests. Perhaps minority personnel recruits were more than proportionately represented in the pool of those provided with guaranteed formal school assignments. This is quite possible as a result of the recent

emphasis on recruiting qualified minority personnel. If so, then AFQT, the guaranteed assignment selection criterion, became more important for minority personnel than for majority personnel in determining occupational classification. Occupational classification was found to influence promotion rate. Therefore, for minority personnel especially, AFQT was an influential variable in determining paygrade.

CROSS-SECTIONAL MODEL

Research Objectives

A cross-sectional study was conducted to supplement the original preservice plus inservice model by controlling for the number of months in the Navy. By controlling for this variable, the strong influence of time in the Navy was neutralized. Therefore, one objective of this cross-sectional model was to determine the mix of significant variables when time in the Navy is held constant. It is of interest to determine whether or not the original and cross-sectional models provide the same results with respect to the significant variables in the models. Furthermore, it is of value to compare majority vs. minority personnel promotion rates at the end of an initial four-year enlistment contract. Do the original and cross-sectional models provide the same results with respect to minority vs. majority advancement?

Individuals selected for the cross-sectional sample were screened in the same manner, with one exception, as those individuals included in the original preservice plus inservice sample. The exception was that the individuals included in the cross-sectional

sample entered the Navy in either April, May, June, or July of 1971.
Therefore, this model constructs an advancement function for individuals
who had approximately four years of active Naval service as of the
file date.[18]

The variables studied in this model were the same as those
studied in the preservice plus inservice model. Time in the Navy was
still considered in order to accommodate the difference of up to three
months which was possible. However, the relative significance of
this variable was expected to be much less than found in previous
models. The multiple correlation, therefore, was expected to drop
considerably.

Cross-Sectional Model Interpretation

Everyone in the cross-sectional model served in the Navy as
an enlisted man between 1971 and 1975 as of the file date. Therefore,
the results of the cross-sectional model are based on the situation
existing during this period. The range of time in the Navy for the
original model is two months to fifteen years, although 50 percent of
the individuals in the original model have no more than twenty-one
months of active service. The original model, because of the frequency
distribution of time in the service, describes the advancement func-
tion most reliably from 1973 to 1975. It is clear that the range and
median values for time in the Navy are very different for the original
and cross-sectional samples. Because the time frames are different,

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[18]Four years of active duty is the normal length of time for
an enlistment contract.

the sample paygrade distributions are different. Thus, the cross-sectional and original model results were not expected to be the same because of the disparate samples from which the models were derived. Model comparisons, then, provide for a further understanding of the Navy enlisted promotion function as well as a further understanding of the relative impact of the significant variables on race-ethnic groups.

Recall that in the original preservice plus inservice model, "other" minority personnel was found to be a significant variable, but the black personnel variable was not. When the significant variables were controlled for, "other" minority personnel were found to be promoted slightly slower, in the aggregate, than either black or majority personnel. Black and majority personnel were found to be promoted at the same rate.

In the cross-sectional model, however, the sample consists of individuals who have four years of active service. Interpretations are based on the results of a specific four-year period. "Other" minority personnel is no longer a significant variable. The black personnel variable is statistically significant but has a positive relationship with paygrade which is weak relative to the other significant variables in the equation. Nevertheless, when the significant variables are held fixed, those blacks still in the service, after four years of obligated service, are found to be promoted at a slightly faster rate than majority personnel and "other" minority personnel. That is, in the aggregate, given a minority member and a majority member who enter the Navy in 1971 and complete their

obligated service and have identical "academic credentials," marriage status, time in paygrade, discipline record, and occupational classification, the minority member will be promoted at least as quickly as the majority member. This phenomenon reflects the emphasis the Navy has placed on minority upgrading since 1972.

The average "academic credential" scores for those personnel in the cross-sectional sample are found to be higher than for those personnel in the original sample. The cross-sectional sample has a greater value for mean time in the Navy than the original sample. Thus, the sample with the greater value for mean time in the Navy has a higher average value for "academic credential" scores than the sample with a lower mean value for time in the Navy. During the four-year time period considered by the cross-sectional model, a great deal of attrition took place. The armed services reduced their manpower requirements considerably in an effort to scale down after Vietnam. The results of the model indicate that the individuals who left the service generally had less impressive "academic credentials" than those who remained.

Model results indicate that, in 1971, approximately 18 percent of the entering recruits were minority personnel. In the cross-sectional model, where each individual included in the model entered the Navy in 1971 and completed four years of active service, 9 percent of the sample is minority personnel. Therefore, it is concluded that approximately 50 percent of the minority personnel entering the Navy in 1971 did not complete their obligated service.

The period between 1971 and 1975 was one of considerable flux with respect to minority upgrading policy and manpower requirements in the Navy. The percentage of minority personnel recruited fluctuated considerably during this period. The Navy established minority personnel recruiting and upgrading goals, including occupational classification priorities for qualified minorities. The scaling down of manpower requirements also took place. As a result, individuals were discharged prior to completion of obligated service. The attrition rate of those individuals having lower "academic credentials" was higher than for those having higher "academic credentials." As already shown, the attrition rate for minority personnel was disproportionately high. It is interesting to note, however, that when the statistically significant cross-sectional variables are held fixed, minority personnel who remained in service, in the aggregate, are found to be promoted slightly faster than majority personnel.

Summary

Generally, interpretations based on the original preservice plus inservice model results are valid here. That is, for the most part, variables found to contribute to the description of the original advancement model also explain the cross-sectional advancement function. Additional insight, however, is provided through model comparisons where the sample time frames and paygrade segments are different.

Although for the most part the variables found to be statistically significant in the original model remain significant in this model, the joint significance of these variables is less than

in the original model.[19] As already mentioned, the multiple correlation was expected to drop considerably as a result of controlling, to a large extent, time in the Navy. The relative lack of significance is also partly due to the difference in periods of personnel upgrading policy during these time periods. Furthermore, the "academic credential" differences between individuals are not as great in the cross-sectional sample as in the original sample. This, and the lack of good representation in the cross-sectional sample for most of the range of enlisted paygrades (only paygrades E3, E4, and E5 are well represented), account for more of the difference between the significance of the combination of variables for the two models.

PERFORMANCE EVALUATION MODEL

Research Objectives

An objective of the performance evaluation model was to determine which, if any, of the on-the-job evaluation variables were significant when introduced into the model. How do the evaluation variables modify the model? Another objective of this model, of course, was to evaluate the relative impact of the current performance evaluations on minority vs. majority personnel promotion rates. Furthermore, comparisons were to be made between the advancement function derived from the preservice plus inservice sample and the advancement function derived from the individuals of this performance evaluation sample.

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[19]The cross-sectional model R^2 is .3849. R^2 for the original model is .8058. The cross-sectional model statistics are found in Appendix E (Table E-1).

Only the performance evaluations for E5 and above are filed on tape. Therefore, the individuals selected for the sample were in paygrades E5 and above. The variables that were initially considered to enter the preservice plus inservice model remained as candidates in this model. In addition, current performance, appearance, cooperation, reliability, conduct, resourcefulness, leadership, equal opportunity, and overall evaluations were also considered to enter the model.

Only paygrades E5 and E6 are well represented in the performance evaluation model, whereas paygrades E1 through E6 are well represented in the original preservice plus inservice model. Furthermore, the performance evaluation model describes the enlisted advancement function during a different time frame than either the original model or the cross-sectional model. The original and cross-sectional models have a median value for time in the Navy of twenty-one months and four years respectively. The performance evaluation model range for time in service is twenty-four months to fifteen years. In this model, the mean and median values for time in the Navy are both seventy-one months. Thus, not only are we looking at a more specific paygrade group than in the other models but also at a different time frame.

Performance Model Interpretation

Concerning the inservice variables, time in service is the most significant in the model. However, it does not display as strong a relationship with the dependent variable in this model as it does in the original preservice plus inservice model. On the other hand, the

occupational classification variables maintain their relative strength of relationship with the dependent variable in the performance evaluation model.

In the original model, the "academic credential" variables were found to contribute, in large part, to the explanation of dependent variable variation. ARI and GCT were found to be the most significant variables and are very important in determining an individual's opportunity to advance in rank. Years of education and AFQT were found to be less important, and CLER and SHOP were found to be far less important, yet statistically significant.

As stated, only paygrades E5 and E6 are well represented in the performance evaluation model. In this model, the "academic credential" variables display less joint significance than that displayed in the original model. ARI shows a strong relationship with the dependent variable. SHOP and GCT are the only other "academic credential" variables that are statistically significant. These variables do not have nearly as much impact on advancement opportunity as does ARI.

The average BTB and AFQT exam scores are higher, and the number of years of education completed are greater for personnel in the E5 and above sample than for members of the original sample. These "academic credential" differences are reminiscent of these same variable differences found in the last section between the cross-sectional sample and the original sample. The mean values of these variables increase, for those remaining in the sample, due to disproportionate attrition over time of individuals with lower "academic credentials."

Approximately 4.2 percent of the sample of personnel in paygrades E5 and above are black and 1.6 percent are "other" minority personnel. In the original model, 10.6 percent and 7.8 percent of the sample are black and "other" minority personnel respectively. The attrition rate for minorities becomes disproportionately high as the median time in the Navy for the sample increases. It is concluded that the great majority of minority personnel entering the Navy do not remain in the service for a longer period (relative time frame of personnel in paygrades E5 or greater) or advance to E5 or greater. The problem of disproportionate minority personnel attrition will be investigated in the retention chapter. Those minority members who do remain, however, enjoy as fast a promotion rate as that of majority members with identical significant variable characteristics. Therefore, neither black personnel nor "other" minority personnel variables are significant in the performance evaluation model.

The joint influence of the current performance evaluations is less than anticipated. Only leadership and appearance are found to show a statistically significant relationship with the dependent variable. However, recall that this model describes the advancement function for paygrades E5 and above only. It is quite possible that these results do not well represent the state of affairs for paygrades E4 and below. The impact of the above two significant variables on race-ethnic groups is now evaluated.

The model results show that minority personnel do receive slightly lower scores on the current performance evaluations than do majority personnel. However, the proportion of both the leadership and

appearance variables variation explained by the race-ethnic variables
is less than 1 percent. This indicates that, in the aggregate, there
is little difference between race-ethnic groups with respect to scores
on leadership and appearance evaluations. This conclusion holds only
when referring to group comparisons for paygrades E5 and above. As
stated, no comment can be made here concerning group performance
comparisons for personnel in paygrades E1 through E4. The role of
performance evaluations and the relative impact on minority personnel
of these evaluations will be examined in the promotion chapter.

Performance Evaluation Model Summary

The performance evaluation model interpretation is based on
the statistical results derived from the E5 and above paygrade sample.
This sample is distinct from the original and cross-sectional samples.
The differences in the characteristics of the samples naturally provide
varying model results.[20] Again, as in the cross-sectional model, the
sample characteristics are different with respect to time in the Navy
and paygrade representation. Comparison of the model results based
on these differences serve to increase our understanding of both the
enlisted advancement function and the relative impact of significant
variables on race-ethnic groups.

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[20]Differences in variables found to be significant and in
model interpretations were noted. The performance evaluation model
multiple correlation is found to be .4802. The performance model
statistics are found in Appendix F (Table F-1).

CONCLUDING REMARKS

The purposes for conducting this statistical analysis were two-fold. First, it was hoped that a good enlisted advancement function could be constructed to explain paygrade level attainment. The second purpose was to evaluate minority vs. majority personnel advancement opportunities with respect to the statistically significant variables derived from the models. On both accounts, the analysis was successful.

Initially, a promotion model was constructed using preservice information such as marital status, region of residence, mental aptitude exam scores, years of education completed, age, etc. One objective of the preservice model was to make race-ethnic group comparisons based on information collected at enlistment and shortly thereafter. Next, the model was expanded by combining preservice information with data on inservice characteristics. Inservice variables included occupational classification, discipline record, time in the Navy, performance evaluation, etc. Again, the race-ethnic group profiles were compared but this time with respect to these inservice variables. The preservice plus inservice model was later refined to include separate race-ethnic models, a cross-sectional model, and a model derived from personnel in paygrades E5 and above. The above models provided for the evaluation of advancement functions constructed from disparate samples. Additional insight was provided through model comparisons where the sample time frames, paygrade distributions, and race-ethnic categories were different.

Generally, the variables found to be significant are consistent from model to model. Exceptions to this were noted. "Academic credential" variables are found to be important and to influence an individual's advancement potential throughout his career. These variable frequency distributions are strikingly different for majority, black, and "other" minority personnel. The "academic credential" variables account for much of the race-ethnic promotion rate differences.

The following inservice variables are found to be statistically related to paygrade level: time in the service, discipline record, leadership and appearance evaluations, and occupational classification. These factors are extremely important in terms of an individual's promotion success. The relative impact of these variables on minority vs. majority personnel was evaluated. Minority personnel are adversely affected by the influence of these variables on the advancement function. The statistical analysis not only identified factors which strongly influence promotion but also measured the relative impact of these factors on race-ethnic group advancement opportunities. Those variables which are regulated by institutional policy were of particular interest.

As stated, the services' formal advancement and professional development systems are investigated in a forthcoming book authored by Herbert R. Northrup, Steven M. DiAntonio, and Dale F. Daniel.[21] In this publication, attention focuses on the areas of occupational

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[21]Note 2, _supra._

classification and assignment, promotion, and retention. The question
of whether the services' institutional policies and affirmative action
objectives are compatible is evaluated. The conclusions derived from
the statistical analysis are helpful in two ways. First, the analysis
answers, in part, the above affirmative action vs. institutional policy
compatibility question. Secondly, the statistical results provide
insight into what the effect will be of modifying the policy regulated
variables to accommodate affirmative action objectives.

APPENDIX A

THE MULTIPLE STEPWISE REGRESSION MODELS: STATISTICAL TECHNIQUE

A stepwise analysis was used in order to identify which variables from the group of explanatory variables available should be used in the regression model. The stepwise analysis technique provided a means of screening the explanatory variables based upon an evaluation of the variables with respect to their relationship with the dependent variable. This technique provided insight into the relative strengths of these relationships between the proposed independent variables and the dependent variable.

A program from the Biomedical Computer Programs (BMD)[1] package, BMDP2R, was used to estimate the parameters of the multiple regression equations in a stepwise manner. The so-called F method stepping algorithm was selected from four possible stepping algorithms. The F method allowed the computer program to move from one regression iteration to the next while evaluating the regression equations. Each iteration provided the opportunity for another variable to enter the regression equation according to the following rule: If one or more available variables were out of the regression equation, the one having the highest F value entered the equation if it passed the tolerance test. That is, the explanatory

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[1]W.J. Dixon (editor), Biomedical Computer Programs (Berkeley, Cal.: University of California Press, 1975), p. 305.

variable outside the equation with the highest computed F value entered

the equation if that value was greater than the F-to-enter limit used

in the program. The standard F-to-enter limit suggested by the program,

namely 4.0, was used.

As already stated, the multiple stepwise regression model provided

information on the relative contribution of the explanatory variables in

explaining the paygrade (dependent variable) reached by an individual.

The program used started with an independent variable and added another

one during each iteration. It stopped making iterations when no remain-

ing variables had a computer F value greater than or equal to the F-to-

enter limit.

An F-to-enter value of 4 required the relationship between the

dependent variable and the combination of explanatory variables to be

significant. The F-to-enter value of 4 required, furthermore, that each

of the independent variables entering the equation be significantly

related with paygrade at least at the .05 level of significance. However,

the F-to-enter value of 4 was low enough to allow the independent

variables which increased the coefficient of multiple determination (R^2)

only slightly to enter the regression equation. This value provided for

a less stringent means of screening variables than, say, a higher F-to-

enter value. A higher F-to-enter value criterion would have allowed

only the most significant variables to enter the regression equation.

But, by using the standard value, the researcher was able to evaluate

the relative importance and contribution of a wider range of statistically

significant variables.

The BMD program provided the statistics to determine whether or not the regression equation was "good." This information was generated during each iteration. The multiple correlation existing between the dependent and independent variables (R^2) was calculated in order to determine how good the regression equation was. The program also computed the regression coefficients for the variables entering the sequential regression equation as well as their F-to-enter values. Finally, a simple correlation matrix was provided by the program.

The multiple correlation (R^2) measures the proportion of the total variation of the dependent variable which is explained by the regression equation. A high R^2 was sought. The higher the R^2, the greater the success of the regression equation in explaining the variation of paygrade level attainment. Because these models were used to obtain insight into the minority personnel upgrading problems, rather than to predict paygrade, the value of R^2 was viewed in conjunction with the other statistics provided by the program. The simple correlation coefficients and the regression coefficients added to the interpretation of the results as well.

The statistical significance of each explanatory variable was determined by an F ratio. The computed value of F is the ratio between the additional variance explained by the addition of each independent variable and the unexplained variance. Tests of significance were performed for each independent variable by comparing the computed F value with respect to the critical F value in the same manner as for the test of overall relationship discussed above. That is, a significant relationship existed between an independent variable and the dependent variable

if the computed F value was greater than the critical F value. The F-to-enter criterion of 4 ensured that the variables included in the regression model were significant at the .05 level of significance.

The program computed the regression coefficients for the significant explanatory variables. In a geometric sense, a regression coefficient represents the slope of the resulting straight line in the plane described by the dependent variable and the corresponding independent variable while holding the other independent variables constant. It is an estimate, obtained from the studied sample, of the unknown population coefficient. The final regression coefficient for a particular independent variable is affected by the other significant independent variables. This is so because the coefficient measures the contribution of the variable in defining the slope of the final regression line which represents the best linear fit based on sample observations. Therefore, the regression coefficient, for each independent variable, measures the change in the dependent variable per unit change in that particular independent variable when all other independent variables are held fixed.

A correlation matrix was computed by the BMD program. Simple correlations provide a measure of association between two variables. The proportion of the variable Y variation which is explained by the variable X is defined by the square of the simple correlation (r^2) for two variables.

APPENDIX B

PRESERVICE MODEL: STATISTICAL RESULTS

Sample

The statistical research conducted deals exclusively with active duty Navy enlisted personnel. The data source used was the Navy enlisted master file located in Washington, D.C. There are approximately 460,000 enlisted personnel in the Navy. From the computer files, a random sample of approximately 90,000 enlisted personnel was extracted. A one or a two in the unit's position of an individual's social security number was used as a random selection mechanism. Additional constraints were imposed on the random sample of 90,000 cases in order to generate the samples used in the models. It was required that each case (individual) be male, enlisted, and Regular Navy, and that each case include all information to be used in the analysis.

Variables

The regression model dependent variable was paygrade. The independent variables that were considered to enter the preservice model were: AFQT, GCT, ARI, MECH, CLER, SHOP, marital status, age at entry, black personnel, "other" minority personnel, and Central Atlantic, Pacific, Southeast, Great Lakes, Southwest, Midwest, Northeast, and Non-Continental United States.

Statistical Results

The independent variables found to be statistically related to paygrade were listed in Table 1. The significant probabilities and standard regression coefficients were also listed as well as their individual contribution to the multiple R^2 value. The correlation matrix for the preservice plus inservice variables evaluated in the models is shown in Table B-1.

Shortcomings of the Model

The regional variables are binary variables indicating an individual's region of residence at the time of enlistment. The random sample of 90,000 cases (individuals) extracted from the master enlisted files listed the individuals in ascending order of social security number. The first three numbers of an individual's social security number indicate the region in which the social security card was issued to that individual.

Five thousand cases from the possible 90,000 provided by Bupers were sampled. If an individual was male, active duty, and had data on the variables included in the model, that individual met the constraints imposed and was therefore eligible to be included in the sample of 5,000. The cases were evaluated one by one to determine whether or not the above constraints were met. The computer program used to extract the 5,000 cases began evaluating cases at the beginning of the Bupers tape reel and worked through approximately 70,000 cases before the 5,000 cases for the sample were extracted. Because the reel did not run through the entire 90,000 cases, individuals with the highest social security numbers were not considered.

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TABLE B-1

PRE-SERVICE PLUS IN-SERVICE CORRELATION MATRIX

		ED YEARS 1	AFQT 2	GCT 3	ARI 4	MECH 5	CLER 6	SHOP 7	BUSTED 8	BLACK 9	ETHNIC 10
ED YEARS	1	1.0000									
AFQT	2	0.4167	1.0000								
GCT	3	0.5015	0.7467	1.0000							
ARI	4	0.4920	0.7281	0.7461	1.0000						
MECH	5	0.2011	0.6113	0.4426	0.3844	1.0000					
CLER	6	0.2765	0.2505	0.3106	0.3404	0.0983	1.0000				
SHOP	7	0.2165	0.5518	0.4750	0.3830	0.6731	0.0988	1.0000			
BUSTED	8	-0.1110	-0.0394	-0.1002	-0.1074	-0.0590	-0.0275	-0.0554	1.0000		
BLACK	9	-0.0785	-0.3553	-0.3478	-0.3301	-0.3270	-0.1475	-0.3391	0.0619	1.0000	
ETHNIC	10	-0.1515	-0.1344	-0.1311	-0.1462	-0.0700	-0.0422	-0.0402	0.0154	-0.1012	1.0000
MARRIED	11	0.2171	0.2305	0.2012	0.2547	0.1351	0.0534	0.1140	-0.0854	-0.0941	-0.1279
CENTRAL	12	0.0012	0.0157	-0.0018	0.0038	0.0118	-0.0081	-0.0119	0.0039	-0.0231	-0.0014
PACIFIC	13	-0.0426	-0.0034	-0.0026	-0.0152	0.0132	0.0355	0.0208	0.0307	-0.0474	0.0102
SOU EAST	14	0.0106	0.0335	0.0446	0.0246	0.0371	-0.0064	0.0399	0.0167	-0.0502	0.0025
GT LAKES	15	0.0025	-0.0140	0.0064	0.0039	0.0101	-0.0077	0.0039	-0.0239	-0.0225	0.0245
MIDWEST	16	0.0210	0.0066	0.0120	-0.0013	-0.0396	0.0270	-0.0134	-0.0327	-0.0368	-0.0019
SOUWEST	17	0.0174	-0.0002	-0.0015	-0.0082	0.0022	0.0162	-0.0040	-0.0099	-0.0069	-0.0250
NONCONUS	18	0.0024	-0.0037	-0.0149	0.0116	0.0174	-0.0231	0.0007	0.0171	0.0338	-0.0560
AGE	19	0.3031	0.1667	0.1901	0.1962	0.0879	0.1028	0.1262	-0.0585	0.0590	-0.0605
RANK	20	0.4562	0.3228	0.5226	0.5749	0.2857	0.1858	0.2697	-0.2469	-0.2418	-0.2318
OPENING	21	-0.0121	0.1134	0.0836	0.0495	0.1536	-0.0017	0.1639	-0.0084	-0.0994	0.0014
CLOSEDTN	22	0.0331	0.0472	0.0144	0.0034	0.0791	-0.0081	0.0605	-0.0225	-0.0687	-0.0123
MONTHS	23	0.3200	0.3559	0.3381	0.4036	0.1612	0.0468	0.1377	-0.1014	-0.1840	-0.2125

		MARRIED 11	CENTRAL 12	PACIFIC 13	SOU EAST 14	GT LAKES 15	MIDWEST 16	SOUWEST 17	NONCONUS 18	AGE 19	RANK 20
MARRIED	11	1.0000									
CENTRAL	12	0.0000	1.0000								
PACIFIC	13	-0.0587	-0.0277	1.0000							
SOU EAST	14	-0.0075	-0.0226	-0.0465	1.0000						
GT LAKES	15	0.0116	-0.0524	-0.1075	-0.0801	1.0000					
MIDWEST	16	-0.0260	-0.0830	-0.1657	-0.1545	-0.3097	1.0000				
SOUWEST	17	0.0006	-0.0147	-0.0301	-0.0248	-0.0571	-0.0871	1.0000			
NONCONUS	18	0.0081	-0.1412	-0.0045	-0.0693	-0.1596	-0.2457	-0.0449	1.0000		
AGE	19	0.1751	-0.0001	-0.0401	0.0048	0.0139	-0.0389	0.0186	0.0316	1.0000	
RANK	20	0.5175	0.0349	-0.0268	-0.0112	-0.0157	0.0126	0.0070	0.0353	0.1773	1.0000
OPENING	21	-0.0130	0.0134	-0.0118	-0.0176	0.0186	-0.0087	0.0191	0.0163	-0.0224	0.0655
CLOSEDTN	22	0.0008	-0.0141	0.0279	0.0075	0.0143	-0.0074	-0.0005	-0.0070	-0.0007	-0.0482
MONTHS	23	0.5775	0.0570	-0.0342	-0.0190	-0.0114	0.0056	0.0078	0.0357	0.1125	0.0329

		OPENING 21	CLOSEDTN 22	MONTHS 23
OPENING	21	1.0000		
CLOSEDTN	22	-0.2439	1.0000	
MONTHS	23	-0.0123	-0.0092	1.0000

As a result of the above method of sample extraction, a random distribution of regions was not obtained. That is, the sample regional distribution was not an accurate distribution of the Navy enlisted population. In many cases, the region in which an individual was issued a social security number was the same as that individual's region of residence at the time of enlistment. In situations where this was the case and where the social security numbers for the region were very high, those individuals from the region were not considered.

The above regional bias was mitigated, in part, by the fact that often the region in which an individual was issued a social security number was not that individual's region of residency at enlistment. The result of this fact was that each regional variable was well enough represented in the sample to be considered by the model. Therefore, investigation of the regional variables was not adversely affected. Care was taken, however, in interpreting findings with respect to the regional variables.

A second bias of the model was the distribution of paygrade. The most pervasive constraint imposed on each case included in the sample required that information be available for each variable considered in the model for that case. Because of the newness of the computerized enlisted records system as well as the method of filing new data in the enlisted files, an individual who recently entered the Navy was more likely to have a complete record than a more senior enlisted man. For this reason, the above constraint, requiring that all information utilized in the model be present, excluded disproportionately more senior enlisted personnel than junior enlisted personnel. As a result, the

distribution of rank in the sample did not represent the true frequency
distribution of rank in the population of Navy enlisted personnel.

The breakdown by rank of personnel included in the sample of 5,000
was as follows: E1, 129; E2, 1501; E3, 759; E4, 660; E5, 1530; E6, 418;
and E7, 4. As can be seen, paygrades E1 through E6 were well represented
in the sample. Paygrade E7 was poorly represented and paygrades E8
and E9 were not represented at all. Again, it must be said that the
sample was not representative of the Navy enlisted population. However,
because of the large number of cases in each of paygrades E1 through E6,
the model was not adversely affected by the lack of paygrade randomness
when considering these paygrades. But nothing can be said about the
significant preservice variables which define paygrade for paygrades
E7 through E9, nor the impact of these variables on minority personnel
in paygrades E7 through E9.

The frequency distribution of the variable time in service clearly
indicated that the probability of an individual being excluded from the
sample was greatly increased by seniority with respect to time in the
Navy. The mean value for time in the Navy was 35 months. The median
value was 21 months. Although the range of time in the Navy for sample
personnel was 2 months to 15 years, approximately 70 percent of personnel
in the sample had less than or equal to 4 years active duty as of June
1975. Therefore, the distribution of time in the Navy for personnel in
the sample was skewed to the left. Because of the greater number of
people in the Navy for periods of time 2 years and less, the reliability
of the model was greater for this period of time.

APPENDIX C

PRESERVICE PLUS INSERVICE MODEL: STATISTICAL RESULTS

Variables

The regression model dependent variable remained paygrade. The independent variables that were initially being considered to enter the preservice model remained as candidates in this model. In addition, occupations with open advancement potential, occupations with closed advancement potential, discipline record and time in service were also considered to enter the model.

Statistical Results

The independent variables found to be statistically related to paygrade were listed in Table 2. The significant probabilities and standard regression coefficients were also listed as well as their individual contribution to the multiple R^2 value.

Shortcomings of the Model

The sample for this model was the same as that of the preservice regression model. Because the sample was the same, the sample bias was also the same. First, the regional frequency distribution of the sample did not accurately represent the regional frequency distribution of the Navy enlisted population. However, because all regions were well enough represented in the sample, inferences were drawn concerning the relative relationships of the regional variables with paygrade level attainment.

Secondly, the sample paygrade frequency distribution did not reflect the true paygrade distribution of the enlisted population. Again, because only paygrades E-1 through E-6 were well represented in the sample, conclusions were drawn concerning the impact of the explanatory variables on personnel promotion opportunities in only these paygrades. Finally, the sample time in service distribution did not reflect the true population distribution of time in Navy.

The Navy has time in paygrade (TIR) requirements that must be fulfilled before an individual is eligible for promotion consideration. This fact distorted somewhat the results of the model. This was a bias of the MONTHS variable. However, because of the short mean length of time in the Navy and the skewness of the rank distribution towards the lower paygrades for the sample, the distortion was not considered severe. One reason for this was that although the time in paygrade (TIR) requirements were applicable for all paygrades, they were more restrictive for paygrades E-6 through E-9. As already stated, paygrades E-6 through E-9 were poorly represented in the sample. There were two additional reasons why the time in grade constraint was mitigated against. First, the time in grade requirements were lengthened to the current requirements only recently. That is, the time in grade requirements were gradually increased since the end of the United States involvement in Vietnam. Therefore, in the past two years, the time in grade requirements have been even less restrictive than today. Secondly, a percentage of recruits graduating from formal school training are automatically advanced to E-4 upon graduation. The standard time in grade and time in service requirements do not apply in these cases.

An additional bias was imposed by the fact that there is an "up or out" policy in the Navy. Again, the distortion was not considered severe. The "up or out" policy pertains only to those individuals wishing to reenlist after the expiration of their initial or succeeding service obligation contracts. Normally, initial enlisted obligated service is for four years. Greater than 70 percent of the sample had less than or equal to four years active duty. Furthermore, most of the so-called "up or out" emphasis is placed on being in an occupation which is not overmanned rather than requiring upward advancement.

APPENDIX D

SEPARATE BLACK AND "OTHER" MINORITY PERSONNEL MODELS: STATISTICAL RESULTS

Sample and Variables

Separate models for both black and "other" minority members were derived from the sample of 5,000. The black subsample consisted of the 524 blacks in the sample. The "other" minority subsample consisted of the 390 "other" minority members in the sample. The dependent variable remained paygrade for both models. The explanatory variables that were considered to enter the preservice plus inservice model remained as candidates in these models with the exception of the race-ethnic variables.

It is noted that the aggregate sample consisted of approximately 18 percent minority personnel. Therefore, a comparison between the minority models and the aggregate model was not a direct comparison of minority vs. majority advancement functions. However, reliable inferences could be made from this section of the study when comparing minority vs. majority personnel advancement functions.

Because the samples for these two models were subsamples of the original 5,000 case sample, the nature of the bias was the same. That is, the subsample frequency distributions of paygrade, time in the Navy, and the regional variables did not reflect the true frequency distributions of these variables in the enlisted population. In the earlier

models, conclusions had to be made with caution. Additional caution had to be exercised in analyzing the results of the black and "other" minority models.

In the sample of 5,000, paygrades E-1 through E-6 were well represented. That is, there were large numbers of personnel in each of these paygrades. Therefore, reliable conclusions were drawn concerning the impact of the explanatory variables on the dependent variable for personnel in these paygrades. The breakdown by paygrade of personnel included in the black subsample was as follows: E-1, 33; E-2, 314; E-3, 76; E-4, 42; E-5, 60; and E-6, 5. The breakdown for personnel included in the "other" minority subsample was as follows: E , 16; E-2, 268; E-3, 28; E-4, 59; E-5, 19; and E-6, 2.

The frequency distribution of paygrade for both the black sub-sample and the "other" minority subsample was more skewed to the left than the aggregate sample paygrade frequency distribution. The same holds true for the time in service frequency distribution. That is, there were paygrades, particularly the higher ones, in both the black subsample and the "other" minority subsample which were poorly repre-sented. Thus, the reliability of the models derived from the above subsamples was decreased. This was more true of the "other" minorities model than for the black model.

Statistical Results

The regression equation and the appropriate statistics for the black model are shown in Table D-1. The results of the regression equation for the "other" minorities model are shown in Table D-2.

Table D-1

Black Model Statistics: Significant Variables Listed in Order of Significance

Variable	Standard Regression Coefficient	Contribution to R^2
Time in Navy[a]	0.663	0.5850
Discipline record[a]	-0.238	0.0722
AFQT[a]	0.129	0.0526
Years of education[a]	0.122	0.0201
SHOP[a]	0.079	0.0086
Marital status	0.059	0.0031
GCT[b]	0.073	0.0029
Open occupation[b]	-0.052	0.0025
		0.7471

[a]Significant at the .005 level of significance.

[b]Significant at the .025 level of significance.

Table D-2

"Other" Minority Model Statistics: Significant Variables Listed in Order of Significance

Variable	Standard Regression Coefficient	Contribution to R^2
Time in Navy[a]	0.500	0.3344
AFQT[a]	0.257	0.1291
Discipline record[a]	-0.188	0.0374
Years of education[a]	0.111	0.0114
Closed occupations[a]	-0.106	0.0105
ARI[b]	0.107	0.0061
		0.5289

[a]Variable significant at the .005 level of significance.

[b]Variable significant at the .05 level of significance.

APPENDIX E

CROSS-SECTIONAL MODEL: STATISTICAL RESULTS

Sample and Variables

Individuals selected for the cross-sectional sample were screened in the same manner, with one exception, as those individuals included in the original preservice plus inservice sample. The exception to this was that the individuals included in the cross-sectional sample entered the Navy in either April, May, June, or July of 1971. Therefore, this model constructed an advancement function for individuals who had approximately four years of active Naval service as of the file date.

The variables studied in this model were the same as those studied in the preservice plus inservice model. Time in service was still considered in order to accommodate the differences of up to three months which were possible. However, the relative significance of this variable was expected to be much less. The multiple correlation, therefore, was expected to drop considerably.

The bias accounted for by time in Navy in the earlier models was no longer with us. Furthermore, because all 90,000 cases of the random file tape were screened to find this cross-sectional sample of 2,204 individuals, the regional bias was eliminated. However, paygrade bias remained. The sample paygrade was as follows: E1, 14; E2, 33; E3, 233; E4, 954; E5, 978; and E6, 2. Again, the problem of poor representation in several paygrades is evident. The reliability of the model was reduced

for all enlisted paygrades other than E3, E4, and E5.

Statistical Results

The regression equation and the appropriate statistics for the cross-sectional model are shown in Table E-1.

Table E-1

Cross-Sectional Model Statistics: Significant Variables
Listed in Order of Significance

Variable	Standard Regression Coefficient	Contribution to R^2
Discipline record[a]	-0.369	0.1225
Time in paygrade[a]	-0.336	0.0931
GCT[a]	0.146	0.1070
Marital status[a]	0.130	0.0210
ARI[a]	0.130	0.0178
SHOP[a]	0.068	0.0054
Time in Navy[a]	0.073	0.0050
Years of education[a]	0.075	0.0051
Black personnel[a]	0.059	0.0025
Open occupation[a]	0.048	0.0025
AFQT[b]	0.064	0.0018
CLER[b]	0.041	0.0015
		0.3852

[a]Significant at the .005 level of significance.

[b]Significant at the .025 level of significance.

APPENDIX F

PERFORMANCE EVALUATION MODEL: STATISTICAL RESULTS

Sample and Variables

Only the performance evaluations for E5 and above are filed on tape. Therefore, individuals selected for the sample were in paygrades E5 and above. The regression model dependent variable remains paygrade. The independent variables that were initially being considered to enter the preservice plus inservice model remained as candidates in this model. In addition, an individual's performance, appearance, cooperative-ness, reliability, conduct, resourcefulness, leadership, overall and equal opportunity evaluations (member's ability to deal with individuals of all race-ethnic groups in a nondiscriminatory manner) were also considered to enter the model.

The regional variable bias no longer was in the sample. This was true because all 90,000 cases of the random file were screened to generate the sample of 3,109 individuals. However, the paygrade bias remained. The enlisted paygrades were represented as follows: E5, 1959; E6, 1139; E7, 11. Only paygrades E5 and E6 are well represented. E7 is poorly represented and paygrades E8 and E9 are not represented at all. The model was reliable for describing the advancement function only for paygrades E5 and E6.

Statistical Results

The regression equation and the appropriate statistics for the performance evaluation model are shown in Table F-1. The correlation matrix for the preservice plus inservice variables evaluated in the performance model is shown in Table F-2.

Table F-1

**Performance Evaluation Model Statistics: Significant Variables
Listed in Order of Significance**

Variables[a]	Standard Regression Coefficient	Contribution to R^2
Time in Navy	0.560	0.2594
Time in Paygrade	-0.280	0.0881
ARI	0.131	0.0474
Leadership evaluation	0.112	0.0227
Open occupation	0.115	0.0229
SHOP	0.091	0.0098
Central Atlantic region	0.098	0.0075
Appearance	0.092	0.0071
Closed occupations	-0.064	0.0044
Southeast region	-0.068	0.0036
Great Lakes region	-0.069	0.0046
GCT	0.072	0.0029
		0.4802

[a]Variables all significant at the .005 level of significance.

TABLE F-2

PERFORMANCE MODEL CORRELATION MATRIX

TABLE F-2 (continued)

PERFORMANCE MODEL CORRELATION MATRIX

	ETHNIC 21	MARRIED 22	CENTRAL 23	PACIFIC 24	SOU EAST 25	GT LAKES 26	MIDWEST 27	SOUWEST 28	NONCONUS 29	AGE 30
ETHNIC 21	1.0000									
MARRIED 22	0.0303	1.0000								
CENTRAL 23	-0.0367	0.0174	1.0000							
PACIFIC 24	-0.0214	-0.0234	-0.0357	1.0000						
SOU EAST 25	-0.0419	0.0216	-0.0420	-0.0458	1.0000					
GT LAKES 26	-0.0295	0.0654	-0.0704	-0.0969	-0.1101	1.0000				
MIDWEST 27	-0.0087	-0.0576	-0.1079	-0.1177	-0.1366	-0.2964	1.0000			
SOUWEST 28	-0.0013	-0.0245	-0.0406	-0.0443	-0.0521	-0.1122	-0.1340	1.0000		
NONCONUS 29	-0.0072	0.0288	-0.0641	-0.0700	-0.0824	-0.1773	-0.2118	-0.0797	1.0000	
AGE 30	-0.0091	0.0362	0.0137	-0.0145	0.0424	0.0160	-0.0745	-0.0148	0.0588	1.0000
RANK 31	-0.0265	0.1306	0.1477	-0.0175	0.1180	0.1117	-0.0953	-0.0093	-0.0852	8.0489
UPENIRK 32	0.0231	-0.0608	-0.0142	-0.0161	-0.0129	0.0619	-0.0291	-0.0101	0.0160	-0.0503
CLOSEUTK 33	0.0117	0.0560	0.0140	0.0162	0.0074	-0.0343	-0.0144	0.0316	0.0229	-0.0179
MONTHS 34	0.0052	-0.0260	0.0949	-0.0463	0.0807	0.0539	-0.0203	0.0	-0.0735	-0.0235

	RANK 31	UPENIRK 32	CLOSEUTK 33	MONTHS 34
RANK 31	1.0000			
UPENIRK 32	0.1210	1.0000		
CLOSEUTK 33	-0.0840	-0.2344	1.0000	
MONTHS 34	0.5093	-0.0935	0.0734	1.0000