MANPOWER POLICY AND THE REENLISTMENT RATE

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Sheldon E. Haber
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THE GEORGE WASHINGTON UNIVERSITY
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13. ABSTRACT

In this paper, the application of contingency table analysis to longitudinal data is illustrated. The data utilized pertain to first-term enlistees in the U.S. Marine Corps. The problem addressed is the assessment of variables influencing the reenlistment decision. On the basis of this assessment, implications for manpower policy are analyzed.

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In this paper, the application of contingency table analysis to longitudinal data is illustrated. The data utilized pertain to first-term enlistees in the U.S. Marine Corps. The problem addressed is the assessment of variables influencing the reenlistment decision. On the basis of this assessment, implications for manpower policy are analyzed.

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0. Introduction

Maintaining force strength in the Navy under the AVF policy now existing in all the services is a new situation. Those charged with Naval recruitment and retention will have new influences to consider in planning their programs. For example, prospective declines over the next few years in the proportion of the population in the prime military age group (see [7]) and a commitment to an all volunteer force suggest that first-term enlistees will provide a smaller percentage of military manpower and, concomitantly, that individuals who enlist two or more times will comprise a larger percentage.

The question of whether this will result in an optimal mix of personnel for meeting the security needs of the nation is difficult to analyze. However, it is clear that greater understanding of the reenlistment decision process is desirable if only to minimize the cost of encouraging those on active duty to remain in that status.

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The objective of this paper is the identification and assessment of some of the factors influencing reenlistment. This knowledge can lead to increased productivity in the work of career planners. Moreover, an increase in the number of reenlistments that can be obtained from a given cohort of first-term enlistees may lead to reduced cost through the retention of experienced military personnel.

In this study specific attention is given to alternative policies for retaining military personnel. The first step in this direction is to delineate those policies that might have an impact on reenlistments. From some studies (see [4], [6], [9]), pay appears to be an important policy variable influencing reenlistment. Closely associated with pay is rank structure. Since promotion policy is intertwined with the pay received by individual servicemen, policies pertaining to promotion can be used by the services in a selective manner, e.g., to encourage reenlistments in specialties experiencing personnel shortages.

Other policies not related to compensation, such as policies affecting job satisfaction, may also bear on the ability of the services to retain personnel and are amenable to variation by a service. By identifying factors that are related to the decision to reenlist and by relating them to policy alternatives pertaining to compensation, personnel satisfaction, etc., an important first step toward the evaluation of such policies can be made.

The data employed in this study come from information collected on individual enlistees in the Marine Corps. These data are particularly useful in that they permit the evaluation of a wide range of policies. Information is available on age, education, rank, length of enlistment, etc., of each enlistee and, of critical importance, whether he reenlisted for military service. The generation of this information requires the maintenance of a longitudinal personnel history file. While this is usually not available, such a longitudinal file has been developed by the Marine Corps. It is this file which is employed in the study. The file illustrates the utility of longitudinal data for assessing manpower policy alternatives in connection with the retention of military manpower. The data base is described in greater detail in Section 1.

The evaluation of manpower policies for retention of personnel is not a simple task. Cost effectiveness criteria may be difficult to quantify. This need not hamper multivariate data analyses that yield information on variables that affect reenlistment. In this study we employ multidimensional contingency table analysis (see [5]) to explore the data. Among other things, this procedure yields the odds of reenlistment to non-reenlistment as a function of the main effects and joint interaction of predictor variables. This provides a means for assessing the importance of each predictor variable in the reenlistment model. The procedure also yields the probability of reenlistment for a profile of predictor variables. This probability can range over a wide interval. For example, the probability of reenlistment is .81 for individual A and .09 for individual B, where A and B have the following profiles:

Probability of Reenlisting

	A	B
Rank	E-5	E-5
Length of Enlistment	4 Years	4 Years
Dependents	One or more	None
Current vs. Primary Billet	Different	Same
Region	West	East
Mental Group	IV	I
Probability of Reenlisting	.81	.09

Discussion of the model is found in Section 2.

One of the findings of the study is that rank is a major factor influencing the reenlistment decision. Although this is not surprising, it is found that this variable becomes important only after a certain level. The contribution of rank to the probability of reenlistment is relatively constant for pay grades below E-4, but it increases for pay grades E-4 and above.[1] For example, among four year enlistees, the probability of reenlistment, conditioned on predictor variables, is about .08 for ranks E-1 through E-3 but increases to .21 for rank E-4 and to .34 for ranks E-5 and above. It should be noted that rank reflects pay and responsibility and these influences are not easily separated.

Other factors besides rank also influence the reenlistment decision and sometimes in unexpected ways. For example, the Marine Corps has stressed the desirability of diversified training, i.e., of shifting personnel so they become proficient in multiple skill areas. It has been speculated that this philosophy, which may introduce uncertainty in planning for a career, has the effect of lowering the reenlistment rate, and that policies that would reduce such uncertainty would increase the probability of reenlistment. This hypothesis is tested and is rejected for the first-term enlistees studied. All other things being equal, the probability of reenlisting was higher by 25 to 150 percent, depending on length of enlistment, for individuals whose last job differed from the one in which they received their primary training than for individuals whose last job was the same as their primary job. These and other findings are described more fully in Section 3. Concluding remarks are presented in Section 4.

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[1] In the Marine Corps, the pay grades E-3, E-4, and E-5 correspond to the ranks of lance corporal, corporal, and sergeant, respectively.

1. The Data Base and Variables Included in the Analysis

The data base is a longitudinal personnel history file developed by the Marine Corps. Hereafter it is referred to as the cohort file. The file contains significant historical information for all entrants into the Marine Corps Regular Establishment from initiation into active duty till day of separation or first reenlistment.[2] The complete file contains information for over 700 thousand first-term enlistees who entered the Marine Corps between calendar years 1962 and 1972. The cohort of enlistees entering the Marine Corps in 1968 was chosen for intensive study since it is the most recent for four year enlistees. Individuals in this group made their reenlistment decisions in 1972.

Several kinds of data are contained in the cohort file. These pertain to the date of entry (active duty accession date); information describing the first-term enlistee (age, race, education, length of enlistment, home of record at the time of enlistment, number of dependents, etc.); significant events related to the enlistee's attachment to the Marine Corps (whether or not basic training was completed, whether or not the initial service contract was completed, whether or not reenlistment occurred); and other information describing his activities while in the military (date of last promotion, current and primary job, etc.).

As can be readily seen, a large number of factors that might affect reenlistment are contained in the cohort file. A complete list of the variables used in the analysis is given in Table 1. The discrete categories employed to measure these variables are shown at the

[2] Only immediate reenlistments, i.e., reenlistments occurring within 24 hours of spearation from service, are recorded. Other types of reenlistments, although not recorded, constitute only a small proportion of total reenlistments. Additionally, individuals who extended their initial term of service for 24 or more months were treated as if they had reenlisted. Individuals who extended for less than this period were excluded from the analysis, i.e., they were treated neither as reenlistees or non-reenlistees.

Table 1

Predictor Variables Used in the Analysis

	Number of Categories	Categories
Group I		
(All enlistees, 1968)		
Rank (K)	4	E-1 or E-2; E-3; E-4; E-5 or above
Dependents (D)	2	Zero; one or more
Race (R)	2	White; non-white
Education (U)	2	Less than high school; high school and above
Military Occupation (O)	4	Ground combat; general repair; clerical and semi-skilled; other skills
Length of Enlistment (L)	3	Two; three; four or six years
Group II		
(All enlistees, 1968)		
Combat (B)	2	In combat (Vietnam); not in combat
Age at Enlistment (A)	3	17; 18 or 19; 20 or more
Current Primary Job (C)	2	Current job same as job for which primarily trained; current job different than job for which primarily trained
Region (N) a/	4	East; North; South; West
County Population (P) b/	5	50,000 or less; 50,001 - 250,000; 250,001 - 500,000; 500,001 - 1,000,000; greater than 1,000,000
Length of Enlistment (L)	3	(See Group I)

a/ Region of residence at time of enlistment.

b/ Population in 1960 of county of residence at time of enlistment.

[continued]

Table 1 (cont'd.)

	Number of Categories	Categories
Group III		
(Two year enlistees only, 1970)		
Rank (K)	3	E-1 or E-2 or E-3; E-4; E-5
Race (R)	2	(See Group I)
Education (U)	2	(See Group I)
Mental Group (G)	3	I or II; III; IV or V
Group IV		
(Four year enlistees only, 1968)		
Rank (K)	4	(See Group III)
Dependents (D)	2	(See Group I)
Race (R)	2	(See Group I)
Education (U)	2	(See Group I)
Time at which Rank is achieved (M)	2	Less than six months before decision; six months or more before decision
Variable Reenlistment Bonus (V)	2	Variable reenlistment bonus offered in military occupation; variable reenlistment bonus not offered in military occupation

right. Since the number of variables that can be handled by the contingency table program in a single application is limited, the evaluation for all Marine enlistees was conducted in two separate steps. Additionally, evaluations were made for two year enlistees only, and for four year enlistees only. (See Table 1 for the variables included in each evaluation.) Most of the variables are self-explanatory; some, however, require further description.

Four military occupational groups are distinguished in the analysis to determine the impact of occupational training in the military on the reenlistment decision.[3] The military specialties included under ground combat are the infantry, artillery, and tank specialties; general repair refers to such occupations as electricians and plumbers; aircraft maintenance, armament repair, telecommunications repair; the clerical and semi-skilled occupations include personnel administration, supply administration, personnel, food service, and motor transport excluding repairmen or mechanics; and such diverse occupations as photography, printing, mapmaking, music comprise the "other skill" group. Because of the broad correspondence between these military occupational groupings and aggregate occupation classes in the civilian sector, e.g., general repair and craftsmen, it was anticipated that this variable would also measure earnings opportunities in civilian life.[4]

The combat variable refers to whether an individual served in Vietnam; it does not necessarily mean that he engaged in combat while there.

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[3]The assignment of military occupation was based on the <u>primary skill area</u> in which the individual was trained.

[4]The correspondence between military and civilian occupations was not expected to be high, however, first, because jobs comparable to the ground combat specialties are absent in the civilian sector and, second, because the very broadness of the military groupings reduced the homogeneity of the occupations included in each group.

For want of a better name, the "current-primary job" variable denotes one aspect of job satisfaction. The data file identifies the primary skill area for which an individual has been trained and the skill area of his most current job.[5] It might be thought that job satisfaction is increased when these are the same. On the other hand, diversification in training may be highly valued by young men who are new or recent entrants into the labor market.

Another measure of job satisfaction is length of time in rank at reenlistment decision. Presumably, the longer the period between promotions prior to the time of reenlistment, the lower the probability of reenlistment. The period of six months was chosen to delineate between "reasonable" and "excessive" length of time in rank.

Mental group is a measure of general intelligence as indicated by the grade received on the Armed Forces Qualification Test. Mental group and level of education are correlated to some extent; both are included among Group III and IV variables (see Table 1) to determine if they exert differential effects on the reenlistment decision.

The variable reenlistment bonus (VRB) is offered on first reenlistment to individuals in specialties with a critical shortage of personnel. It varies in amount and may be as large as $8,000. Although four levels of VRB are recognized by the military, the VRB variable is restricted to two categories, occupation areas in which a VRB is offered and occupation areas in which a VRB is not offered. Whether an individual receives a VRB depends on whether he reenlists in an occupation in which it is offered. The first two digits of the MOS (Military Occupation Specialty) code are used to identify occupations in which a VRB is available.

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[5]In determining current and primary skill areas, the first two digits of the four digit Marine Corps military occupation specialty code were used. These digits distinguish different occupation areas, e.g., infantry utilities (construction), personnel and administration, legal services, photography, air controllers, etc.

The variables enumerated in Table 1 fall into three broad categories. The first category contains pay and occupation information. The former is measured by rank. Military occupation is of interest in itself, but can also measure pay in the civilian sector. A second category relates to personnel management policies that impinge on job satisfaction. The current-primary job and length of time in rank variables fall into this category. The remaining variables in the analysis are in neither of these two categories, but in an important sense they are amenable to management. For example, although manpower policy has only a minimal impact on the residence of individuals prior to their entry into service, enlistees from different regions of the country may have different propensities to reenlist. As indicated below, this may indeed be the case. Hence, the effectiveness of reenlistment policies is not independent of policies relating to the enlistment of first-term personnel. Similarly, although it is easier to enlist an individual for two years than for four years, all other things being equal, the probability of reenlistment is substantially lower in the former case than the latter, suggesting that policies designed to induce four year enlistments, such as occupational guarantees, may need to be considered by policy makers concerned with reducing the cost of retention.[6]

[6] The possible conflict between alternative policies is clearly seen here as it was stated earlier that diversification of skill training also tends to increase the reenlistment rate. In this case, the apparent conflict can be resolved since not all individuals desire specific training, and for those individuals who don't, training in a number of skill areas tends to increase reenlistments.

2. The Contingency Table Model

In this section the structure underlying contingency table analysis is discussed, and the mechanics of obtaining odds and probabilities for the reenlistment event are illustrated.

The reenlistment analysis is based on a large number of categorical variables. Regression analysis and similar multivariate techniques for continuous variables become inefficient and inappropriate for this situation. Multidimensional contingency table analysis, which we now explore, is more suitable.

We are interested in accounting for the variation in reenlistments in a parsimonious way and with meaningful factors. Consider a simple example with two factors, reenlistment decision and rank. Assume rank is categorized into two levels, i.e., high rank or low rank. The reenlistment decision and rank of forty individuals might produce the table

	High Rank	Low Rank
Reenlistment	10	10
No Reenlistment	10	10

which yields probability estimates

	High Rank	Low Rank
Reenlistment	.25	.25
No Reenlistment	.25	.25

or more generally

	High Rank	Low Rank
Reenlistment	p_{11}	p_{12}
No Reenlistment	p_{21}	p_{22}

The overall probability that a person reenlists is $p_{11} + p_{12} = .5$. The probability that a reenlistment is of high rank is also .5 for

$$\frac{p_{11}}{p_{11} + p_{21}} = \frac{.25}{.25 + .25} = .5$$

In this example, the probabilities of reenlistment are the same regardless of rank. This table suggests reenlistment decision and rank are independent.

A related measure denoted as an "odds" measure has an interpretation well known to bettors. In the above example, if one wagers that a person selected at random reenlists, the overall odds, i.e., the odds of reenlistment regardless of rank are one to one or even. Knowledge that the bet is on the high rank group or low rank group does not change the odds. Realistically, however, the probability and odds that a high rank and a low rank will reenlist are not the same. As an illustration, consider the table

	High Rank	Low Rank
Reenlistment	15	5
No Reenlistment	5	15

This gives probability estimates

	High Rank	Low Rank
Reenlistment	.375	.125
No Reenlistment	.125	.375

From this table the overall probability of a person reenlisting, $.375 + .125 = .5$, remains the same but the probability that a high rank reenlists is

$$\frac{.357}{.375 + .125} = .75 \ .$$

This differs substantially from the overall probability of 0.5 which no longer summarizes the data. The odds will change as well, being three to one for high rank, one to three for low rank. The information contained in this and the preceding table is described in terms of three characteristics: the overall probability that a person will reenlist, the probability that a low rank will reenlist, and the probability that a high rank will reenlist.

The basic objective in a more complex table is to identify the minimum number of probabilities that must be specified to adequately describe the table. The specification of probabilities given in the last example can be used. However, recent research has developed a more formal descriptive model similar to analysis of variance or regression models. Instead of dealing directly with cell probabilities, it is convenient to deal with their logarithms. These new variables, the logarithms of the cell probabilities, have characteristics similar to measurement data, and they can be incorporated into a linear model whose parameters indicate the contribution of the various factors and their interactions to the cell probability.

The linear model[7] for estimating logarithms of p_{tk} (for our analysis where we fix and employ only the marginals) is

(1) $$\ell n p_{tk} = \mu + \alpha_t^T + \alpha_k^K + \alpha_{tk}^{TK} , \qquad t = 1, 2, \qquad k = 1, 2$$

where $\ell n p_{tk}$ is the natural logarithm of p_{tk} .

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[7]While we are asserting the model here, it can be developed by employing the minimum discrimination information index suggested by Kullback [5]. It is also discussed and applied by a number of authors. The monograph by Cox [3] asserts this model as an analytical approximation to normal theory linear models and provides much detail.

The constant μ is a general mean indicating the average value of $\ell n p_{tk}$. The parameter α^T indicates the "effect" of reenlistment decision on $\ell n p_{tk}$ independent of rank; α^K measures the effect of rank on $\ell n p_{tk}$ independent of reenlistment decision. The parameter α^{TK} measures the interaction effect of reenlistment decision and rank on $\ell n p_{tk}$. For the first example cited, where all the p_{tk} (and consequently all the $\ell n p_{tk}$) are equal, α^T and α^K are zero since $\ell n p_{tk}$ does not vary with either reenlistment decision or rank; and for this reason, too, α^{TK} is zero. Hence, p_{tk} is equal to the anti-log of μ, which in this case is the overall probability that a person reenlists.

The model in (1) allows the step-by-step computation of cell probabilities similar to regression analysis. For example, if reenlistment decision is considered as a function of rank, the odds of reenlistment $(t = 1)$ to non-reenlistment $(t = 2)$ for a given rank are

$$\frac{p_{1k}}{p_{2k}}, \quad \text{say } k = 1 \text{ for high rank, } k = 2 \text{ for low rank.}$$

Using the model in (1) to obtain these odds in logarithmic form (denoted hereafter as the log odds), we get

$$(2) \qquad \ell n \frac{p_{1k}}{p_{2k}} = (\mu + \alpha_1^T + \alpha_k^K + \alpha_{1k}^{TK}) - (\mu + \alpha_2^T + \alpha_k^K + \alpha_{2k}^{TK}) = 2\alpha_1^T + 2\alpha_{1k}^{TK}$$

where $\alpha_1^T = -\alpha_2^T$ and $\alpha_{1k}^{TK} = -\alpha_{2k}^{TK}$.

Since the α parameters measure deviations from a general mean, a deviation from the mean at one level leads to a deviation in the opposite direction at the other level. Replacing $2\alpha_1^T$ and $2\alpha_{1k}^{TK}$ by β^T and β_k^{TK} to simplify the notation in (2) yields

$$(3) \qquad \ell n \frac{p_{1k}}{p_{2k}} = \beta^T + \beta_k^{TK}, \quad k = 1 \text{ for high rank, } k = 2 \text{ for low rank.}$$

From (3) the log odds of reenlistment to non-reenlistment are seen to depend on β^{T} , the general mean for the log odds, and β_{k}^{TK} , the relationship between rank and reenlistment decision.

To further illustrate these ideas, let us consider another example. Assume that reenlistment is dependent on two variables: length of enlistment, L , and the presence or absence of dependents, D . Then $p_{t\ell d}$ represents the probability that a specified reenlistment decision is made given an individual's length of enlistment and dependency status. Following the previous example, the logarithm of the odds of reenlisting to not reenlisting as a function of the predictor variables can be written as

$$(4) \qquad \ell n \frac{p_{1\ell d}}{p_{2\ell d}} = \beta^{T} + \beta_{\ell}^{TL} + \beta_{d}^{TD} + \beta_{\ell d}^{TLD} \quad .$$

Each one of the β parameters has the same interpretation given previously. β^{T} is a general mean for the log odds. The β_{ℓ}^{TL} , $\ell = 1$ (two year enlistment), $\ell = 2$ (three year enlistment), $\ell = 3$ (enlistments of four or more years)[8] are numerical measures of the impact on reenlistment of enlistment length. Similarly, the β_{d}^{TD} are numerical measures of the impact of dependents on reenlistment where the subscript d identifies the number of dependents, $d = 1$ (no dependents), $d = 2$ (one or more dependents). The parameters $\beta_{\ell d}^{TLD}$ are interaction terms. It may be, for example, that the presence of dependents may influence the reenlistment decision of four year enlistees differently than that of three or two year enlistees. First, dependents are more common among four year enlistees and they tend to have more of them. Second, four year enlistees who serve to end of term tend to be older at the time they must decide whether to reenlist. Hence the impetus to reenlist may

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[8] Almost all enlistments in this category are four year enlistments; for convenience this group is referred to as the four year enlistment group.

be greater among members of this group than would be indicated by adding the separate effects of dependency status and length of enlistment. The presence of a joint interaction effect of length of enlistment and dependency status on reenlistment implies a non-zero β_{32}^{TLD} .

By exponentiation of each side of the log-linear model (4), the odds of reenlisting to not reenlisting (hereafter referred to simply as the odds of reenlistment) can be written in the form

$$(5) \qquad \frac{p_{1\ell d}}{p_{2\ell d}} = \delta^{T} \delta_{\ell}^{TL} \delta_{d}^{TD} \delta_{\ell d}^{TLD}$$

where the δ's are the anti-logs of the β's . In this form of the model, δ^{T} can be interpreted as the overall mean odds of reenlistment which is modified by more detailed information about the levels or values of the predictor variables and their interactions.

For the full model incorporating the Group I variables described in Section 1, the odds of reenlisting become

$$(6) \qquad \frac{p_{1\ell druok}}{p_{2\ell druok}} = \delta^{T} \delta_{\ell}^{TL} \delta_{d}^{TD} \delta_{r}^{TR} \delta_{u}^{TU} \delta_{o}^{TO} \delta_{k}^{TK} \delta_{\ell d}^{TLD} ,\ldots, \delta_{\ell dk}^{TLDK} ,\ldots$$

where $\delta_{\ell d}^{TLD}$,... take into account first order interaction effects,

effects, $\delta_{\ell dk}^{TLDK}$,... second order interaction effects, etc. For the full model, the overall odds δ^{T} is estimated as

$\hat{\delta}^{T} = e^{\hat{\beta}^{T}} = e^{-2.60} = .074$, that is, the odds are .074 to one in favor or reenlistment.[9] If the odds of reenlistment are desired for Marines who enlist for four years, we need to compute

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[9]Note that this is not the odds that would be computed directly from the observations, but rather from their logarithmic transforms, then averaging, then transforming back to the odds domain. Thus, this "mean odds" is a multiplicative mean, not an additive mean.

$$\hat{\delta}^{T}\ \hat{\delta}_3^{TL} = (.074)\ (2.46) = .182\ .$$

Thus, the odds of reenlistment increase from .074 to .182 for Marines who enlist for four years.

The calculation can be extended, for example, to Marines who enlist for four years who have one or more dependents by the end of their enlistment period. If these independent variables entered linearly in the model, the estimated odds for reenlistment would be given by $\hat{\delta}^{T}\ \hat{\delta}_3^{TL}\ \hat{\delta}_2^{TD}$, but since dependency status and length of enlistment are found to interact jointly on enlistment, the odds of enlistment for this group of individuals are given by

$$\hat{\delta}^{T}\ \hat{\delta}_3^{TL}\ \hat{\delta}_2^{TD}\ \hat{\delta}_{32}^{TLD} = (.074)\ (2.46)\ (1.72)\ (1.46) = .457\ ,$$

where the last term measures the interaction effect of L and D . Note, the odds of reenlistment for four year enlistees with one or more dependents would have been substantially underestimated if the first order interaction effect had been omitted from the calculation. As a final illustration of how the odds of reenlistment can be computed for individuals characterized by a large number of attributes, we show the estimated odds of reenlistment for non-white four year enlistees with less than a high school education who have attained the rank of E-4 and have one or more dependents:[10]

$$\hat{\delta}^{T}\ \hat{\delta}_3^{TL}\ \hat{\delta}_2^{TD}\ \hat{\delta}_{32}^{TLD}\ \hat{\delta}_2^{TR}\ \hat{\delta}_1^{TU}\ \hat{\delta}_3^{TK}\ \hat{\delta}_{33}^{TLK} =$$

$$(.074)\ (2.46)\ (1.72)\ (1.46)\ (1.58)\ (1.22)\ (1.46) = 1.286\ .$$

The odds of reenlistment for this group of individuals is 1.29 to one

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[10] As in the preceding illustrations, the superscripts are the same as those used in Table 1 to denote the variables examined in the study; the estimates are based on Group I variables which are shown in Appendix Table 1.

compared to .074 to one over all individuals. Notice that in this calculation another third order interaction, that of rank and length of reenlistment $(\hat{\delta}_{33}^{TLK})$, is of sufficient importance to warrant inclusion in the model.[11]

As can be seen from these examples, the estimation of a small number of δ's permits the computation of odds of reenlistment for individuals having very diverse characteristics. It should be noted that as in the case of regression analysis, the coefficients of the linear model (4) (and consequently the δ's in (6)) show the effect of a change in a variable holding all the other variables constant. Thus, $\hat{\delta}_{\ell}^{TL}$ measures the direct effect of length of enlistment on the odds of reenlistment. If an indirect effect with dependency status is also present, this is measured by $\hat{\delta}_{\ell d}^{TLD}$. Both the direct and indirect effects of length of enlistment are net of the effects of other variables such as rank, education, race, etc. That is, the effects of variation in the latter variables on the odds of reenlistment are taken into account in the computation of $\hat{\delta}_{\ell}^{TL}$ and $\hat{\delta}_{\ell d}^{TLD}$.

Given the odds of reenlistment for individuals with a given set of characteristics, it is a simple matter to compute the probability of reenlistment for the group from the relationship

$$(7) \qquad \text{Odds of reenlistment} = \frac{\text{probability of reenlisting}}{\text{probability of not reenlisting}} .$$

For example, if the probability of reenlisting, p, is .07, then the probability of not reenlisting, $1-p$, is .93, and the odds of reenlistment are .074 to one. Solving for p in (7) yields

$$(8) \qquad \text{Probability of reenlisting} = \frac{\text{odds of reenlistment}}{1 + \text{odds of reenlistment}} .$$

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[11]Since $\hat{\delta}_{3}^{TL}$ was previously included in the calculation, it is not entered a second time.

For the illustrations given above, one finds that the probability of re-enlisting corresponding to the odds of reenlistment is as follows:

Odds of Reenlistment	Probability of Reenlisting
.074	.07
.182	.15
.457	.31
1.286	.56

In these calculations it is important to distinguish between individual δ's referred to as "odds factors" (e.g., δ^{TL}, δ^{TD}, δ^{TLD}) which indicate how the overall mean reenlistment odds, δ^{T} , is modified and the <u>product</u> of δ's (e.g., $\delta^{T}\,\delta^{TL}\,\delta^{TD}\,\delta^{TLD}$) which measures the odds of reenlistment for individuals with a specified set of characteristics. Since (8) converts the odds of reenlistment for a given group of individuals to the probability of reenlistment for that group, it cannot be applied to the individual δ's .

The above discussion makes clear that a large number of parameters may enter the contingency table model, thus raising the problem of identifying which parameters are to be included in a model and which are to be excluded. Statistical distribution theory and a measure I^* , which is similar to R^2 , the multiple correlation coefficient in regression analysis, is used to resolve this problem. A description of this model is given in [5].

In regression analysis the explanatory value of a set of predictor variables is measured by the percentage of variation in the dependent variable explained by the predictor variables. The base measure of variation in regression analysis is the sum of squares about the mean of the dependent variable, i.e., $\Sigma(Y_i - \bar{Y})^2$. As predictor variables are added to the model, the predicted values of the dependent variable, $\hat{Y}_i$, are used to measure the amount of variation, $\Sigma(\hat{Y}_i - \bar{Y})^2$, explained. The percentage of base variation explained is then

$$100\ R^2 = 100\ \frac{\Sigma(Y_i - \bar{Y})^2 - \Sigma(Y_i - \hat{Y}_i)^2}{\Sigma(Y_i - \bar{Y})^2}\ .$$

One method of measuring the contribution of any particular variable is the change in R^2 when that predictor variable is added to the model.

For contingency tables, the base measure of variation is computed either as the chi-square statistic[12]

$$\Sigma\ \frac{(0 - E)^2}{E}$$

or the information measure

$$2\ \Sigma\ 0\ \ell n\ \frac{0}{E}$$

under the hypothesis that all β parameters in (4) except the general mean are zero. I^* is then the percentage of base variation explained by the introduction of some collection of β parameters into the model, i.e.,

$$I^* = \frac{(\Sigma\ 0\ \ell n\ \frac{0}{E})_{\text{Base}} - (\Sigma\ 0\ \ell n\ \frac{0}{E})_{\text{Model}}}{(\Sigma\ 0\ \ell n\ \frac{0}{E})_{\text{Base}}}\ .$$

In practice, an I^* of 70 percent or better is desired. Sometimes a lower value is acceptable because increasing I^* requires the addition of many interaction parameters with the consequent difficulty of interpretation. The prime objective is to find the most important parameters. When the number of observations is large as is the case in this study, parameters signifying marginal impact will be statistically significant. In the models discussed in the next section, the convention is adopted of excluding parameters when they increase I^* by less than two percentage points.

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[12]The symbol 0 stands for the observed cell count and E the estimated cell count. The summation is over all cells in a table.

3. Factors and Policies Relating to Reenlistment

In discussing the substantive findings of the study, it will be useful to first present some quantitative measures of the impact of the variables examined on reenlistment and then explore the policy implications that may be drawn from the findings. As noted, the Marine cohort file provides a large body of information for examining some of the factors influencing the reenlistment decision. The number of observations entering into each of the four applications of the model and the percentage of variation in reenlistments explained by each Model I^*, is shown below.

Population	Population Size	Variables a/	Percentage Variation Explained by Model, I^*
All entrants into the Marine Corps in 1968	57,519	Group I	88
All entrants into the Marine Corps in 1968	29,756	Group II	74
Two year enlistees entering the Marine Corps in 1970	5,132	Group III	83
Four year enlistees entering the Marine Corps in 1968	10,350	Group IV	79

a/ See Table 1 for the variables included in each application of the contingency table model.

The difference in the number of observations among applications of the model is due to the lack of data for some of the variables. In order for an individual to be counted into an appropriate cell category, a valid data entry is required for each of the variables. As can be inferred from the figures above, completeness of reporting was best for Group I variables and poorest for Group II variables. As can be seen also, the models yield uniformly high values of I^*. This was achieved by examining all direct and first order effects; hence, parameters measuring second and higher order effects were not included in the models.

The odds of reenlistment and probabilities of reenlisting for the models incorporating Group I and II variables are shown in Tables 2 and 3.

Table 2

Odds of Reenlistment and Probability of Reenlisting

	Odds of Reenlistment	Probability of Reenlisting
Length of Enlistment a/		
Two Years	.041	.04
Three Years	.055	.05
Four Years	.182	.15
Race a/		
White	.047	.04
Non-white	.117	.10
Military Occupation a/		
Ground combat	.056	.05
Clerical and related	.073	.07
Other	.084	.08
General repair	.087	.08
Region b/		
East	.068	.06
North	.075	.07
South	.096	.09
West	.130	.12
Education a/		
High School or above	.061	.06
Less than High School	.090	.08
Combat b/		
In combat (Vietnam)	.076	.07
Not in combat	.104	.09
Age at enlistment b/	c/	d/
County Population b/	c/	d/

a/ Holding all other Group I variables (see Table 1) constant.

b/ Holding all other Group II variables (see Table 1) constant.

c/ Not included in the model because the odds of reenlistment were not significantly different from the overall odds. The overall odds for Group II variables was .089, for Group I variables .074.

d/ See footnote c.

Table 3

Odds of Reenlistment and Probability of Reenlisting

A. Odds of Reenlistment by Length of Reenlistment

	Length of Enlistment (in years)		
	2	3	4
Rank a/			
E1, E2	.014	.018	.079
E3	.019	.023	.095
E4	.037	.042	.266
E5 and above	.274	.258	.514
Dependents a/			
None	.030	.037	.072
One or more	.056	.080	.457
Current-Primary Job b/			
Same Current-Primary Job	.028	.054	.181
Different Current-Primary Job	.089	.087	.239

B. Probability of Reenlistment by Length of Enlistment

	Length of Enlistment (in years)		
	2	3	4
Rank a/			
E1, E2	.01	.02	.07
E3	.02	.02	.09
E4	.04	.04	.21
E5 and above	.22	.21	.34
Dependents a/			
None	.03	.04	.07
One or more	.05	.07	.32
Current-Primary Job b/			
Same Current-Primary Job	.03	.05	.15
Different Current-Primary Job	.08	.08	.19

a/ Holding all other Group I variables (see Table 1) constant.

b/ Holding all other Group II variables (see Table 1) constant.

These figures pertain to all entrants into the Marine Corps in 1968. Similar figures based on Group III and IV variables are shown in Tables 4 and 5, respectively. The figures in Table 4 pertain to two year enlistees only who entered the Marine Corps in 1970; the figures in Table 5 to four year enlistees only who entered the Marine Corps in 1968.[13] To illustrate the interpretation to be given to these figures, one notes from Table 2 that when the variation in such factors as education, race, rank, etc., are held constant, the odds of reenlistment are .182 to one for four year enlistees.[14] The odds of reenlistment are then used to compute

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[13]The major portion of the analysis is based on Tables 2 and 3. Tables 4 and 5 help evaluate factors that could not be included in the earlier models because of computer limitations; they also yield additional important information clarifying and refining the initial findings.

[14]As explained in Section 2, this figure is obtained by multiplying $\hat{\delta}^{T}\ \hat{\delta}_{3}^{TL}$. Each of the reenlistment odds figures in Tables 2 and 3 involves the product of $\hat{\delta}^{T}$ and other odds factors. The odds factors underlying the estimates in these tables are shown in Appendix Tables 1 and 2. Similarly, the odds factors underlying Tables 4 and 5 are shown in Appendix Tables 3 and 4, respectively.

It should be noted that care must be exercised in comparing the figures in Tables 2 and 3 with those in Tables 4 and 5. For example, since Table 5 is restricted to four year enlistees, the odds of retirement for four year enlistees with one or more dependents is $\hat{\delta}^{T}\ \hat{\delta}_{2}^{D} = (.24)(2.72) = .653$ (see Appendix Table 4 for odds factors). The analogous of this figure in Table 3, which includes two, three, and four year enlistees, has been computed above as $\hat{\delta}^{T}\ \hat{\delta}_{3}^{TL}\ \hat{\delta}_{2}^{TD}\ \hat{\delta}_{32}^{TLD} = (.074)(2.46)(1.72)(1.46) = .457$ (see Appendix Table 1 for odds factors). For a number of reasons the odds of reenlistment (and probability of reenlisting) in Tables 2 and 3 are not the same as in Tables 4 and 5. The most important reason for this is that in the former set of tables the data have been pooled to reduce the number of zero cells in the contingency table. Second, the variables considered in each of the models from which the tables are constructed are different. Overall, however, the figures in these two sets of tables are highly consistent.

Table 4

Odds of Reenlistment and Probability of Reenlisting: Two Year Enlistees a/

	Odds of Reenlistment	Probability of Reenlisting
Rank		
E-1, E-2, E-3	.006	.01
E-4	.041	.04
E-5	.102	.09
Race		
White	.038	.04
Non-white	.054	.05
Education		
High School and above	.034	.03
Less than High School	.060	.06
Mental Group		
I, II	.022	.02
III	.041	.04
IV	.102	.09

a/ Holding all other Group III variables (see Table 1) constant.

Table 5

Odds of Reenlistment and Probability of Reenlisting: Four Year Enlistees a/

	Odds of Reenlistment	Probability of Reenlisting
Rank		
E-1, E-2, E-3	.041	.04
E-4	.461	.32
E-5	.751	.43
Dependents		
Zero	.089	.08
One or more	.653	.40
Mental Group		
I, II	.180	.15
III	.166	.14
IV	.461	.32
Race		
White	.204	.17
Non-white	.281	.22
Education	b/	c/
Variable Reenlistment Bonus	b/	c/

	Time at Which Rank is Achieved		Time at Which Rank is Achieved	
	Six Months or Less	More than Six Months	Six Months or Less	More than Six Months
Rank				
E-1, E-2, E-3	.013	.127	.01	.11
E-4	.522	.407	.34	.29
E-5	.979	.577	.49	.37

a/ Holding Group IV variables (see Table 1) constant.

b/ Not included in the model because the odds of reenlistment were not significantly different from the overall odds, .24.

c/ See footnote b.

the probability of reenlisting for each variable, again holding constant the other variables included in the analysis.

Table 2 contains predictor variables whose interaction effects are minimal. That is, the variables are either independent of each other or, if not independent, their combined effect on reenlistment is negligible. The variables in Table 3, in contrast, are time dependent and the interaction effect with length of enlistment is considerable. For example, as previously mentioned, the odds of reenlistment for four year enlistees with one or more dependents will be underestimated if the interaction effect between dependency status and length of enlistment on reenlistment is not taken into account; and, consequently, the contribution of dependency status to the probability of reenlisting will also be underestimated.

As can be seen from Tables 2 and 3, the probability of reenlisting varies over a considerable range for some variables and over a negligible range for others. For four year enlistees with no dependents, the probability of reenlisting is .10; for four year enlistees with one or more dependents, the probability of reenlisting rises to .24. On the other hand, the probability of reenlisting is found to be approximately the same for enlistees of different age groups and from counties with different sized populations,[15] namely, .08 (based on Group II variables).

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[15]The former finding is not inconsistent with declining reenlistment rates among older enlistees since older enlistees tend to be better educated and enlist for shorter time periods. The data indicate that the propensity to reenlist is independent of age when variations in factors correlated with age are taken into account.

Similarly, the lack of association between the reenlistment propensity and the population size variable may be explained by the inclusion in the analysis of variables with which the latter is correlated, e.g., educational attainment. Another explanation is also possible, i.e., that military service results in a leveling of differences in mobility and outlook toward continued military service that might exist between individuals residing in areas of different population size at

Using the range in reenlistment probabilities as a measure of impact on reenlistments,[16] the variables included in the model have been grouped into three categories of importance: important, moderate or low importance, not important. The importance of one variable, the variable reenlistment bonus, could not be ascertained with the same confidence as the other variables; the reasons for this are deferred for the moment.

Important	Moderate or Low Importance	Not Important	Undetermined Importance
Rank	Military Occupation	Race	Variable Reenlistment Bonus
Length of Enlistment	Education	Age at Enlistment	
Dependents	Combat	County Population	
Current-Primary Job	Time at which Rank is Achieved		
Region			
Mental Group			

It should be recognized that this classification is very gross as the range in reenlistment probabilities depends on the manner in which a variable is measured. For example, the range in reenlistment probabilities would be much greater for the dependency variable if dependency groups 0,1,2,...,8 or more had been used in place of the 0,1 or more classification that is utilized in the study. Nonetheless, the measurement groupings utilized seemed reasonable in light of conventional usage in delineating individuals by characteristic.[17]

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time of enlistment. It should be noted, however, that this leveling effect does not occur for geographic region of residence at entry into service.

[16]The odds of reenlistment could also be used as a measure of impact on reenlistment; the probability measure is somewhat easier to interpret since its range is from zero to one.

[17]Additionally, the ordering of variables within categories is approximate since the variables included in the model are not always the same.

From Tables 2 and 3, rank is seen to be an important factor in influencing reenlistments. These data indicate, however, that among Marines there is a minimum threshold before rank becomes an effective inducement to reenlistment, and that its importance tends to increase as the level of rank increases.[18] This somewhat unexpected finding, which holds for enlistees regardless of length of enlistment, has important policy implications for it suggests that reenlistments are sensitive to the distribution of pay as well as the average level of pay. The policy of the Marine Corps to promote its personnel through the lower ranks at a slower rate than the other services is a rational one in view of the findings presented here. Slow rates of promotion through the lower ranks, particularly among two and three year enlistees, do not appear to be detrimental to reenlistment. But given that a determination has been made that a particular individual would make a desirable careerist, advancement to E-5 or higher would appear warranted in order to substantially increase the probability of reenlistment.

Table 5 sheds some additional insight into the relationship between rank and the reenlistment decision. Not only does rank affect this decision, it is also influenced, although to a much lesser extent, by time at which rank is achieved. Among four year enlistees who attain the higher ranks, promotion within the last six months of the first-term increases the probability of reenlistment from one-sixth to one-third. Apparently, the satisfaction associated with promotion, increases the propensity to reenlist.

The contribution of military occupation to reenlistment was expected to be less for the general repair and other skill occupations

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[18]As noted, pay, responsibility, and authority increase with rank and hence it is not possible to disentangle these different correlates of rank using the data at hand. Since the reenlistment rate has been shown to be related to relative military/civilian earnings, see [4], [6], [9], it is assumed in the discussion that follows that the relationship between rank and the probability of reenlisting is similar to that between military pay and the probability of reenlisting.

than for the ground combat and clerical and semi-skilled occupations since civilian earnings in the former occupations are generally higher than in the latter ones. The opposite was found to be true, however. For example, all other things being equal, the probability of reenlisting is 60 percent higher for individuals whose primary job is general repair than for individuals whose primary job is a ground combat specialty. One reason for this surprising finding may be that the highly aggregated military occupation groups are a poor proxy of expected civilian earnings because they are not numeric magnitudes and/or do not conform well to civilian occupations. Or, Marine enlistees may not view their military training as providing entry into comparable civilian jobs since a relatively large proportion, 44 percent of the 1968 cohort, lacked a high school education. For the Marine, placement in a craftsmen or professional occupation (such as photography) may provide job status and attendant satisfaction that is unlikely to be matched in the civilian sector. Thus, it may be the attainment of status (and a high level of military pay) rather than the possibility of higher civilian earnings, explains the higher reenlistment probability in the general repair and other skill occupations. As noted earlier, primary job assignments are not made with an eye toward increasing reenlistments. Yet, reenlistments might be increased if career planners allocated more time counseling enlistees in general repair and other skill occupations on the advantages of a career in the military.[19]

The variable next in importance in determining the propensity to reenlist appears to be length of enlistment. As can be seen from Table 2, all other things taken into account, the probability of reenlisting among four year enlistees is quite different from two and three year enlistees. In part, the difference in reenlistment propensities may be due to the larger proportion of draft induced volunteers among individuals

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[19] Once again the higher probability of reenlistment in general repair and other skill occupations does not imply a higher reenlistment rate among these specialties since the individuals filling these jobs typically have a higher educational attainment or AFQT (Armed Forces Qualification Test) score than individuals placed in other specialties.

who enlisted for less than four years. To further investigate the importance of the draft, the cohort of two year enlistees entering the Marine Corps in 1970 was also examined to see if the reenlistment rate of this group was higher than that of the 1968 cohort of two year enlistees. A higher reenlistment rate for the 1970 cohort might be expected, first, because draft pressure was less and, second, because the unemployment rate rose from 3.6 percent in 1968 to 4.9 percent in 1970. The probability of reenlistment, however, was found to be almost the same for the two groups indicating that four year enlistees do have a much greater propensity to enlist than shorter term enlistees.

This finding suggests that reenlistments can be substantially increased by raising the intake of four year enlistees. This may not be achievable, however, without incurring an increase in the cost of recruitment. Although the magnitude of these costs is not known, an estimate of the benefits can be calculated. For example, consider the reenlistment probability of four year enlistees who reach the rank of E-4 with that of two year enlistees who attain the rank of E-5 or above (Table 3). The probability of reenlistment is approximately the same for each of these groups. Hence, a measure of the benefit associated with a policy of recruiting four year enlistees who are promoted to E-4 versus recruiting two year enlistees who are promoted to E-5 or above is the difference in pay between rank during, say, the difference in initial enlistment periods.[20] Under these conditions, the differential benefit in favor of the former policy is in the neighborhood of $2,434.[21] Again, the differential cost between these alternative policies needs to be calculated. If judged by the average cost of recruitment of $180 per man-year in fiscal year 1972 [2], cost may be small

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[20]This would be the case if the two year enlistee reenlisted for a two year period, thus serving a total of four years (the last two of these at rank E-5 or above.

[21]Estimated by taking the difference in regular military compensation between E-5's and E-4's (see [8], p. 7521) for a period of two years.

relative to the differential benefit.[22]

Another variable exerting considerable influence on the propensity to reenlist is number of dependents. Dependency status affects reenlistment in a number of ways but, on balance, the probability of reenlistment is higher among enlistees with dependents than those without dependents. This is particularly evident for four year enlistees for whom the probability of reenlistment is five to six times higher for individuals with one or more dependents than for individuals with no dependents. The higher reenlistment rate for the former group is not attained without cost, however, since dependency status confers valuable benefits in the form of dependency allowances, housing and medical services, and commissary privileges. The resources necessary to finance such benefits might be used to pay for other forms of compensation which may have greater impact on reenlistment than dependency benefits. Evaluating this and similar tradeoffs, however, requires information which is not at hand.

The effect of diversified job experience on reenlistment has been noted above. Regardless of enlistment length, among individuals who change jobs at least once, the odds of reenlistment are equal to or exceed the average for <u>all</u> individuals. A plausible explanation for this phenomenon is that young people in general are uncertain of the occupation they wish to pursue and, hence, desire a number of job experiences. This may be particularly true of Marine Corps enlistees whose educational attainment is not as high as that of enlistees in the other services. It should be noted that the finding of a higher reenlistment propensity among job changers does not imply that the reenlistment rate is monotonically related to the number of job changes. Too frequent changes in job interfere with job training and can be expected to reduce the propensity to reenlist. Additionally, the

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[22]Other costs not mentioned here need also to be taken into account. For example, all other things being equal, four year enlistees may have a higher propensity to "drop out" of the Marine Corps prior to completion of service than shorter-term enlistees. This aspect of preferred service length is beyond the scope of the discussion.

relationship between job changes, reenlistment and/or efficiency may be quite different among career personnel than among first-term enlistees. Despite these caveats, the Marine Corps policy of providing diversified training appears to result in a higher first-term reenlistment rate. The probability of reenlisting appears to be higher also if promotion occurs close to termination of one's term of enlistment, although the impact of this predictor is small compared to the change-of-job predictor.

As is the case for length of enlistment, the composition of Marine enlistments can be varied in terms of the region from which enlistees are recruited. Although it has been observed that the enlistment rate differs among regions, little is known about geographical differences in the propensity to reenlist. The data examined here suggest that such differences exist; and that among enlistees from the West the propensity to reenlist is twice as high as among enlistees from the East.[23]

Somewhat surprising is the finding that the probability of reenlistment for individuals who served in Vietnam is not much smaller than for individuals who had no Vietnam service. Even more surprising is the relatively small differential in the propensity to reenlist between high school and non-high school graduates.[24]

The relationship between educational attainment and the propensity to reenlist is not straightforward, however. Table 4 indicates the reenlistment differential is quite strong among two year enlistees, while Table 5 indicates that it is negligible among four year enlistees. It may be that four year enlistees make a tentative commitment to military service and that the strength of this commitment is independent of educational attainment.

A somewhat similar relationship to the one just noted is found between mental group (MG) and reenlistment. Among two year enlistees,

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[23]In defining region, the Census classification is used.

[24]This may be due to the inclusion in the analysis of other variables correlated with educational attainment, for example, length of enlistment (see [1]).

the probability of reenlistment increases continuously as mental group diminishes. But among four year enlistees, the probability of reenlistment is the same for mental groups I, II and mental group III, but is twice as high for individuals in mental group IV. This poses the possibility of a policy dilemma for the Marine Corps, namely, the conflict between attaining a high quality career force (assuming that such a force cannot be attained with a high proportion of MG III's) and meeting overall manpower requirements. The extent to which this conflict is a real one depends on additional empirical data, e.g., data on labor productivity by mental group and data on accessions and turnover, which are far afield from the primary focus of the study.

Several factors were found to have little impact on reenlistment. These were race, age, and population size of county in which individuals resided prior to enlistment. It should be noted that the estimates of the probability of reenlisting by race differed depending on the variables considered in the analysis. As can be seen by comparing Tables 2, 4, and 5, the differential in the reenlistment probability between non-whites and whites is much smaller when mental group is included as a predictor variable in the model. This suggests that the impact of race, per se, is minimal and may be explained in terms of the percentage of individuals in MG IV among non-white and white enlistees. One might expect the proportion of MG IV's to be greater among the former than among the latter on the basis of white-non-white wage differentials in the civilian and military sectors. Thus, the exclusion of mental group appears to result in apparent rather than real differences between whites and non-whites in the propensity to reenlist.[25]

One factor related to the reenlistment decision, namely, the variable reenlistment bonus (VRB) could not be easily assessed. As indicated

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[25] The same conclusion, that the propensity to reenlist is similar among whites and non-whites, is found in [6] and [9]. These studies employ regression analysis and include a measure of military/civilian earnings by occupation and race. Unfortunately, similar data classified in detail, appropriate to this study, were not available.

above, this is a one-time bonus given to individuals who reenlist in occupations with a critical shortage of personnel. The VRB variable was included in the analysis to see if the probability of reenlistment differed among occupations in which a VRB was offered vs. occupations in which a VRB was not offered. Holding such factors as length of enlistment (by considering four year enlistees), rank, education, etc., constant, no difference was found in the reenlistment probability between occupations structured in this manner. It might be supposed on the basis of this finding that VRB is not an effective monetary tool for increasing the reenlistment rate. Although this may be the case for the Marine Corps, it would be risky to draw this conclusion solely on the basis of the data at hand, since it is entirely possible that the reenlistment probability for the VRB occupations would be less than that for the non-VRB occupations in the absence of the VRB. Because of this difficulty, other methodological approaches may provide a more efficient means for assessing the impact of this predictor variable.

4. Summary

A major contribution of this study is to illustrate the kinds of analyses that can be performed, given the availability of well-designed longitudinal personnel history files and multivariate statistical models. The particular context of the paper is the reenlistment decision among first-term enlistees in the Marine Corps. The objectives of the study are to quantify the factors influencing reenlistment and to explore some of the implications for manpower policy stemming from the quantification procedure. The methodology employed in satisfying these objectives is contingency table analysis. This methodology provides an estimate of the odds of reenlistment to non-reenlistment, which is translatable into a probability of reenlisting associated with a given factor holding other factors constant.

A number of important implications for manpower policy in the Marine Corps are suggested by the findings of the study. First, among the 14 variables considered as impacting on the reenlistment decision, the most important appears to be rank, i.e., military pay, although responsibility and authority are also related to rank. Of particular significance, the contribution of rank to the probability of reenlisting appears to be small below the rank of E-4 but increases rapidly for ranks E-5 and above.[26] This finding suggests that rank structure, as well as the average level of rank, affects reenlistments, and that the rank structure which minimizes the unit cost of reenlistment is one which has a high percentage of enlisted personnel in the lower and upper ranks but only a small percentage in the intermediate ranks.

A second important factor influencing reenlistments is initial length of enlistment. All other things being equal, the propensity to enlist is markedly different among four year enlistees than among two and three year enlistees. For example, the probability of reenlisting is almost the same among four year enlistees attaining the rank of E-4 as among two year enlistees attaining the rank of E-5, suggesting the possibility of a reduction in the cost of reenlistment from the recruitment of four year enlistees. This conclusion, however, is tentative since other factors important to cost-benefit analysis in this area need to be considered.

The study provides evidence in support of the Marine Corps philosophy of diversification of skills. When other factors such as education, race, etc., are taken into account, the propensity to reenlist is found to be higher for enlistees whose current and primary skill areas are different than for enlistees whose current and primary skill areas are the same, and this is particularly true among individuals who enlist for two or three years. The effects of job transfers on propensity to reenlist among "career" personnel and personnel efficiency were not examined as they were beyond the scope of the study.

The affect of military occupation on reenlistment is noticed in another way. The probability of reenlistment is higher among the hard-

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[26] Additionally, at least among four year enlistees, the probability of reenlisting is higher among E-4's and E-5's if they have been promoted to these ranks during the six months prior to the expiration of their first term of service.

skill occupations than among the soft-skilled occupations, perhaps because the former offer a degree of status that is unlikely to be attained in the civilian sector by the average Marine.

Still another finding is that the probability of reenlisting varies by geographic region of residence prior to entry into the Marine Corps, being highest in the West and lowest in the East.

A somewhat surprising result was the lack of a strong relationship between level of education and reenlistment. This was particularly true among four year enlistees (but less true for two year enlistees). Analogously, for four year enlistees, the probability of reenlisting was the same among individuals in mental group III as in mental groups I and II. This constancy is probably due to the tentative long-term commitment made to military service by four year enlistees. On the other hand, it was found that the probability of reenlisting is substantially higher among four year enlistees in mental group IV than among four year enlistees in mental groups I, II, and III.

Several factors were found to have little impact on reenlistment. These were race, age, and population size of county in which individuals resided prior to enlistment.

Further research is suggested to evaluate alternative policies for retaining individuals with dependents. Current benefits to this group result in a substantially higher propensity to enlist vis-a-vis individuals without dependents, but it may be that less costly alternative forms of remuneration would be equally effective at raising the overall reenlistment rate. Additional research is also needed to measure the impact of the variable reenlistment bonus. Aggregate time series data are more appropriate for this purpose than longitudinal personnel history data.

To summarize the findings, it appears that a variety of factors impinge on the reenlistment decision. Besides pay, other factors, such as those relating to personnel practices, are also important. The study also indicates that the problem of retention is intimately related to the problem of recruitment. Thus, the findings are of interest to both recruiters and career planners. Finally, the study demonstrates the utility of longitudinal personnel history data and of contingency table analysis for estimating the probability of a particular individual re-enlisting, given that he is a candidate for reenlistment, and, by extension, the probability of other related events of interest to manpower managers.

REFERENCES

[1] AZARI, A. and IRELAND, C. T. (1973). Length of Enlistment - A Contingency Table Analysis. Technical Memorandum Serial TM-1097. Econometric Research on Navy Manpower Problems, Graduate School of Arts and Sciences, The George Washington University.

[2] BENNETT, JAMES T. and HABER, SHELDON E. (1972). On the Application of Marginal Productivity Analysis to the Allocation of Recruiters Within the Military Services. Technical Paper Serial T-257. Program in Logistics, Institute for Management Science and Engineering, The George Washington University.

[3] COX, D. R. <u>The Analysis of Binary Data</u>. London, England: Methuen and Co., 1972.

[4] GRUBERT, HARRY and WEIBER, RODNEY. "Navy Reenlistments: The Role of Pay and Draft Pressure." <u>Studies Prepared for the President's Commission on an All-Volunteer Armed Force</u>. Vol. 1, 1970.

[5] KULLBACK, S. (1973). The Analysis of Contingency Tables - A Methodological Exposition. Technical Report Serial TR-1116. Econometric Research on Navy Manpower Problems, Graduate School of Arts and Sciences, The George Washington University.

[6] NELSON, GARY R. "Economic Analysis of First-Term Re-enlistments in the Army." <u>Studies Prepared for the President's Commission on an All-Volunteer Armed Force</u>. Vol. 1, 1970.

[7] STEWART, CHARLES T., JR. (1973). Demographic Trends and Naval Manpower Policies. Technical Report Serial TR-1122. Econometric Research on Navy Manpower Problems, Graduate School of Arts and Sciences, The George Washington University.

[8] U.S. HOUSE OF REPRESENTATIVES. Committee on Armed Services. Pay and Allowances of Uniformed Services Pursuant to Title 37, United States Code (Public Law 87-649 (76 Stat. 451)) As Amended Through January 18, 1972 and Supplementary Material. U.S. Government Printing Office, 1972.

[9] WILBURN, ROBERT C. "Impact of Income, the Draft and Other Factors on the Retention of Air Force Enlisted Men: A Cross Section Analysis." Studies Prepared for the President's Commission on an All-Volunteer Armed Force. Vol. 1, 1970.

APPENDIX

Table 1

Estimating Odds Factors of Reenlisting to Not Reenlisting: Group I Variables

Overall Odds of Reenlisting ($\hat{\delta}^{T}$)		0.074
Rank ($\hat{\delta}^{TK}$)		
(1) [a/]	E-1, E-2	0.46
(2)	E-3	0.46
(3)	E-4	1.00
(4)	E-5 and above	4.48
Dependents ($\hat{\delta}^{TD}$)		
(1)	Zero	0.58
(2)	One or more	1.72
Race ($\hat{\delta}^{TR}$)		
(1)	White	0.63
(2)	Non-white	1.58
Education ($\hat{\delta}^{TU}$)		
(1)	Less than high school	1.22
(2)	High school and above	0.82
Military Occupation ($\hat{\delta}^{TO}$)		
(1)	Ground combat	0.76
(2)	Clerical and related	0.98
(3)	Other skills	1.13
(4)	General repair	1.17
Length of Enlistment ($\hat{\delta}^{TL}$)		
(1)	Two years	0.55
(2)	Three years	0.74
(3)	Four years	2.46

[continued]

APPENDIX

Table 1 - continued

Rank by Length of Enlistment ($\hat{\delta}^{TLK}$)

Rank	Length of Enlistment (in Years)		
	2	3	4
E-1, E-2	0.76	0.71	0.94
E-3	0.98	0.90	1.13
E-4	0.90	0.76	1.46
E-5	1.49	1.05	0.63

Dependents by Length of Enlistment ($\hat{\delta}^{TLD}$)

Dependents	Length of Enlistment (in Years)		
	2	3	4
None	1.25	1.17	0.68
One or more	0.80	0.85	1.46

a/ The row numbers in parentheses correspond to the subscripts in the text, $\hat{\delta}^{TK} = 0.46$, $\hat{\delta}_2^{TD} = 1.72$, etc.

APPENDIX

Table 2

Estimating Odds Factors of Reenlisting to Not Reenlisting: Group II Variables

Overall Odds of Reenlisting ($\hat{\delta}^{T}$)	0.089
Combat ($\hat{\delta}^{TB}$)	
In combat (Vietnam)	0.85
Not in combat	1.17
Age at Enlistment ($\hat{\delta}^{TG}$)	a/
Current-Primary Job ($\hat{\delta}^{TC}$)	
Same current-primary job	0.73
Different current-primary job	1.38
Region ($\hat{\delta}^{TN}$)	
East	0.76
North	0.84
South	1.08
West	1.46
County Population ($\hat{\delta}^{TP}$)	b/
Length of Enlistment ($\hat{\delta}^{TL}$)	
Two years	0.56
Three years	0.77
Four years	2.32

Current-Primary Job vs. Length of Enlistment ($\hat{\delta}^{TLC}$)

	Length of Enlistment (in Years)		
Current-Primary Job	2	3	4
Same	0.77	1.08	1.20
Different	1.30	0.92	0.84

a/ Denotes subscripts in text.

b/ Not significantly different from 1.00.

APPENDIX

Table 3

Estimated Odds Factors of Reenlisting to Not Reenlisting: Group III Variables

Overall Odds of Reenlisting ($\hat{\delta}^{T}$)		.045
Rank ($\hat{\delta}^{TK}$)		
(1) a/	E-1, E-2, E-3	.14
(2)	E-4	.91
(3)	E-5	2.26
Race ($\hat{\delta}^{TR}$)		
(1)	White	.84
(2)	Non-white	1.19
Education ($\hat{\delta}^{TU}$)		
(1)	Less than high school	1.33
(2)	High school and above	.75
Mental Group ($\hat{\delta}^{TG}$)		
(1)	I, II	.49
(2)	III	.91
(3)	IV	2.26

a/ Denotes subscripts in text.

APPENDIX

Table 4

Estimated Odds Factors of Reenlisting to Not Reenlisting: Group IV Variables

Overall Odds of Reenlisting ($\hat{\delta}^{T}$)		.24
Rank ($\hat{\delta}^{TK}$)		
(1) a/	E-1, E-2, E-3	.17
(2)	E-4	1.92
(3)	E-5	3.13
Dependents ($\hat{\delta}^{TD}$)		
(1)	Zero	.37
(2)	One or two	2.72
Race ($\hat{\delta}^{TR}$)		
(1)	White	.85
(2)	Non-white	1.17
Education ($\hat{\delta}^{TU}$)		b/
Time in Rank ($\hat{\delta}^{TM}$)		
(1)	Six months or less	.78
(2)	More than six months	1.28
Mental Group ($\hat{\delta}^{TG}$)		
(1)	I, II	.75
(2)	III	.69
(3)	IV	1.92
Variable Reenlistment Bonus ($\hat{\delta}^{TV}$)		b/

Time at which Rank is Achieved vs. Rank ($\hat{\delta}^{TKM}$)

	Rank		
Time at which Rank is Achieved	E-1, E-2 E-3	E-4	E-5
Six months or less	.41	1.45	1.67
More than six months	2.43	.69	.60

a/ Denotes subscripts in text.

b/ Not significantly different from 1.00.

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