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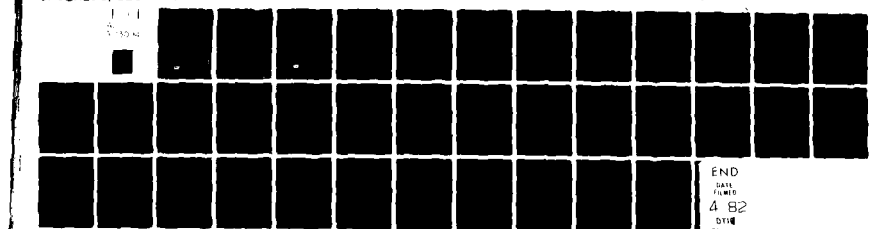

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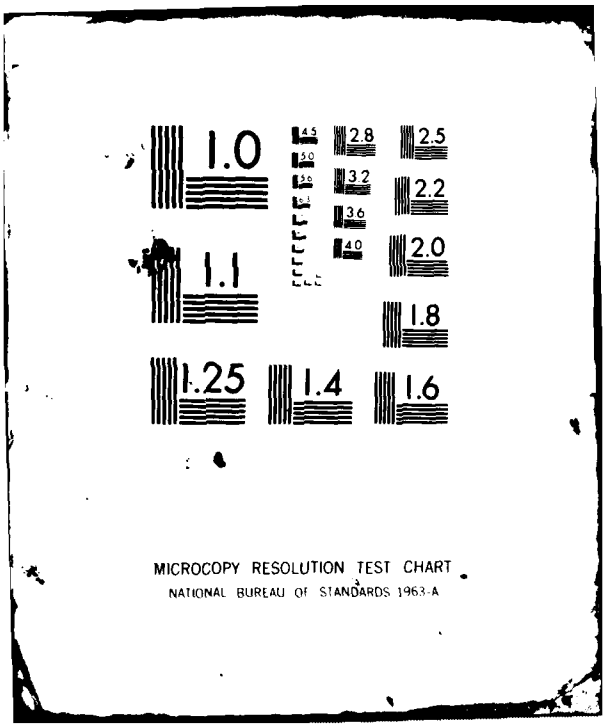
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THE INFLUENCE OF NON-PECUNIARY FACTORS ON LABOR SUPPLY

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CENTER FOR NAVAL ANALYSES

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The Influence Of Non-Pecuniary Factors On Labor Supply:

The Case Of Navy Enlisted Personnel

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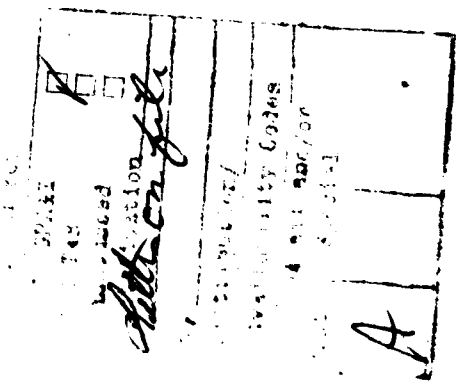

1. Introduction

Economists have long been interested in the effects of non-pecuniary elements on the equilibrium prices that prevail in output and factor markets.[1] In particular, non-pecuniary elements play a large role in the determination of equilibrium wage rates and the self-selection of individuals with dispersed tastes into various occupations. Although this problem has been analyzed with some success in the civilian sector of the economy,[2] most of the labor supply studies have been primarily concerned with estimation of wage elasticities rather than estimation of the effects of non-pecuniary elements. Further, the interaction between the wage elasticities and non-pecuniary elements has been neglected.

The military sector provides a unique opportunity to study the interaction between pecuniary and non-pecuniary elements. In particular, sea duty is the major non-pecuniary element influencing the reenlistment decisions of Navy enlisted personnel. The pecuniary aspects of the Navy reenlistment decision have been examined at some length,[3] but our paper is the first to assess the effects of sea duty on both the location and the elasticity of the reenlistment supply curve. Previous studies have been unable to address this question since they used cross-section

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1. For theoretical discussions of pricing in differentiated markets, see Rosen(1974), Sattinger(1977), and Goldberg(forthcoming).

2. See Thaler and Rosen(1974), for example.

3. See Grubert(1970),Kleinman and Shughart(1974), and Enns(1977).

data, and thus estimated only a single "average" pay response. By contrast, our study uses time series data on each of several Navy occupational groups, so that we may estimate a different pay response within each group. Our results support the hypothesis that the pay response is inversely related to the incidence of sea duty. That is, larger pay increases are required to elicit a given reenlistment response in those occupations where the incidence of sea duty is high. This finding has a direct application to the management of the Navy's reenlistment bonus program, as well as to other compensation issues such as the optimal amount of sea pay.

In the next section we discuss in somewhat more detail our data, the Navy occupational structure, the variation across occupations in the amount of sea duty, and the unique features of the military compensation system. The second section develops an economic model of the reenlistment decision. The third section shows our empirical results. Finally, a brief summary concludes the paper.

2. Preliminaries

The Data

The data for this study were provided by the Defense Manpower Data Center (DMDC). DMDC assembled for us a data file on all Navy enlisted personnel who made a first-term reenlistment decision between FY1974 and FY1978.[4] Our sample contains

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4. Navy enlisted personnel may reenlist for a period of three to six years. First-term reenlistments are those that occur between the third and sixth years of service.

background and military history data on about 220,000 individuals.

The Navy has over 70 enlisted occupations, called ratings. These range from very high skilled electronics technicians (ET) to relatively unskilled Boatswain's Mates (BM). For purposes of this analysis, we divided the Navy into 16 occupational areas. Each area is an aggregation of ratings which are similar in terms of training, job requirements, and working conditions.

These occupational areas are listed in Table 1 along with the sample size and the proportion of careerists in sea duty in each area. (Appendix A contains a list of the ratings included in each area.) As the table indicates, the extent of sea duty varies considerably by occupational area, being the highest in such groups as Ship Maintenance and Marine Engineering and lowest in Health Care and Cryptology.

Sample Reenlistment Statistics

Table 2 displays first-term reenlistment rates by fiscal year for the 16 occupation groups. The data reveal a significant increase in reenlistment rates between FY1974 and FY1975, clearly due to the large increase in civilian unemployment that occured during that period. Between FY1975 and FY1978, rates generally declined. As the data in table 3 below on reenlistment bonuses indicate, much of this decline is explained by a reduction in bonuses. Generally speaking, the data in Table 2 illustrate an inverse relationship between the extent of sea duty and reenlistment rates.

TABLE 1: NAVY ENLISTED OCCUPATIONAL AREAS

		Sample Size	% of Total	Percent of Careerists in Sea Duty
1.	Ship Maintenance	10,956	4.96	69.8
2.	Health Care	16,624	7.54	26.9
3.	Logistics	19,637	8.90	50.4
4.	Marine Engineering	35,557	16.10	69.7
5.	Weapons Systems/Control	12,781	5.79	63.2
6.	Aviation Maintenance	37,889	17.18	30.9
7.	Construction	6,752	3.06	46.3
8.	Administration	18,055	8.18	29.1
9.	Ship Operations	5,480	2.48	65.1
10.	Communications/Sensor Systems	17,955	8.14	50.7
11.	Aviation Ground Support	8,004	3.63	45.6
12.	Data Systems	3,170	1.44	41.6
13.	General Seamanship	9,790	4.44	61.8
14.	Ordnance	7,858	3.56	59.2
15.	Cryptology	6,264	2.84	6.3
16.	Media	3,794	1.72	27.2
	Total	220,566		

TABLE 2

FIRST-TERM REENLISTMENT RATES BY OCCUPATION GROUP, FY 1974-78

	1974	1975	1976	1977	1978
1.Ship Maintenance	17.4	32.6	21.8	20.9	18.7
2.Health Care	20.5	28.3	21.7	20.6	20.0
3.Logistics	15.6	41.5	31.3	31.7	29.4
4.Marine Engineering	27.6	33.6	24.8	23.3	21.3
5.Weapons Systems/Control	28.3	21.4	25.2	28.3	24.1
6.Aviation Maintenance	24.4	34.8	28.1	25.3	22.5
7.Construction	28.0	31.6	15.5	13.8	13.3
8.Administration	23.8	33.6	27.5	31.5	29.5
9.Ship Operations	12.0	23.0	20.8	19.2	17.7
10.Communications/Sensor Systems	19.5	23.8	30.1	24.0	23.3
11.Aviation Ground Support	15.6	27.3	22.9	28.3	24.2
12.Data Systems	28.5	21.1	16.3	20.6	27.2
13.General Seamanship	18.7	30.5	24.8	35.4	22.3
14.Ordnance	18.9	32.4	29.1	38.7	36.0
15.Crypotology	13.2	19.2	26.6	32.5	33.9
16.Media	28.6	21.4	17.3	18.5	15.7
Total	21.9	30.5	25.6	25.5	23.6

The Military Compensation System

The military compensation system is characterized by several unique features. First, there is very little flexibility in the compensation system. The basic measure of military pay, called Regular Military Compensation (RMC), is received by everyone with the same paygrade and length of service (LOS)[5]. The Selective Reenlistment Bonus (SRB) is the only significant occupationally variable pay.[5] The SRB is the product of (1) monthly basic pay at the time of reenlistment, (2) an SRB multiple ranging from 1 to 6, and (3) years of reenlistment commitment, ranging from 3 to 6. Prior to FY1980, bonuses ranged up to a maximum of $15000 and were paid in annual installments over the length of reenlistment. Since then, they have been paid in lump-sum, and the maximum has been raised to $20000.

Average bonus multiples for each occupational area are shown in Table 3. There is a substantial amount of within and across-occupational variation in SRB multiples during our sample period. SRB multiples are usually changed by the Navy when career manning levels fall short of or exceed desired levels, usually at the start of each fiscal year. The general decline in multiples after FY1975 was due in part to a reduction in the size of the Navy enlisted force, but also to political pressures to reduce military manpower costs. This variation in SRB multiples pro-

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5. RMC is comprised of basic pay, allowances for food and quarters, and a "tax advantange" owing to the non-taxability of allowances. Aside from bonuses, other occupationally variable pays include sea and submarine pay. Yet, prior to FY1980, these pays were trivial, amounting to less than 2 percent of RMC.

TABLE 3

AVERAGE FIRST-TERM BONUS MULTIPLE BY OCCUPATION GROUP, FY 1974-78

	1974	1975	1976	1977	1978
1.Ship Maintenance	4.8	4.7	3.6	3.6	2.4
2.Health Care	2.0	1.0	1.0	1.0	.7
3.Logistics	1.0	1.5	1.0	1.3	1.5
4.Marine Engineering	4.6	4.6	3.6	4.3	3.8
5.Weapons Systems/Control	3.2	1.7	1.9	2.7	2.7
6.Aviation Maintenance	3.0	2.4	1.5	1.6	1.5
7.Construction	3.0	2.7	1.0	1.0	.8
8.Administration	1.9	1.6	1.0	1.0	.8
9.Ship Operations	4.7	4.6	3.8	3.3	2.7
10.Communications/Sensor Systems	5.0	2.6	2.5	2.2	2.2
11.Aviation Ground Support	1.9	1.2	1.4	2.1	1.6
12.Data Systems	3.0	1.2	1.2	1.6	2.6
13.General Seamanship	2.5	2.4	1.7	2.5	1.5
14.Ordnance	2.9	3.7	3.7	4.3	4.1
15.Cryptology	2.7	1.7	1.6	1.9	1.9
16.Media	3.4	1.5	1.0	1.0	.8

vides us with substantial variation in military pay during our sample period. Importantly, the SRB changes that occured during this period were due to exogenous factors, obviating the need to model a potential link running from reenlistment rates to bonus multiples as well as the link running from bonus multiples to reenlistment rates.

The last unique feature of the military compensation system is the retirement system, which now vests individuals in an immediate, lifetime inflation-protected annuity after 20 years of service. This system casts a long shadow on reenlistment decisions prior to 20 years of service. Yet, whether a change in the system would have any effect on first-term reenlistment decisions is a subject of analysis below.

3. An Economic Model of Reenlistment Behavior

We begin the development of our theoretical model by considering an individual at the end of his first term of military service. This individual faces a problem of deciding to remain for one or more terms of additional service. That is, he faces a problem of decision-making over multiple time horizons. Will he stay for at least one more term or will he leave immediately? To address this question, we define the following:

M_j=the individual's expected military pay in each future year of service.

$j = 1....n^*$, where n^* equals the maximum allowable additional years of service.

R_{jn} =yearly retired pay the individual will

receive after n more years of service, j=n+1...T,

where T equals life expectancy.

W_{j0} =the future civilian earnings stream the individual expects to receive if he leaves immediately, j=1...T.

W_{jn} =the future civilian earnings stream the individual if he leaves after n more years of service.

p =the individual's yearly rate of time preference.

$d^j = (1/(1+p))^j$ =the present value at the time of the reenlistment decision of a dollar received j years in the future, j=1...T.

Our individual must evaluate the returns to staying and the return to leaving over n possible future time horizons.[6] We define the cost of leaving over each of these horizons, C_n, as the difference between the present value of the income stream from staying n more years and then leaving and the income stream from leaving immediately. Thus, C_n equals

$$\sum_{j=1}^{n} M_j d^j + \sum_{j=n+1}^{T} (R_{jn} + W_{jn})\, d^j - \sum_{j=1}^{T} W_{j0} d^j$$

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6. Our model is similar to the model of occupational choice in the civilian sector discussed by Boskin(1974). The difference is that the individual in Boskin's model makes a once-and-for-all decision, whereas the individual in our model reevaluates his decision at the end of each term of enlistment. A related model of sequential decision-making is found in Gotz and McCall(1980).

The first two summations express the present value of the income stream from staying n more terms and then leaving, while the right hand summation is the present value of the income stream from leaving immediately. In principle, the income stream from leaving immediately includes already vested retirement benefits, although there is currently no such vesting for first-term decision-makers.

Will the individual stay or leave? To answer this, we introduce a yearly "distaste for service" factor, denoted δ. This factor is the yearly differential between military and civilian life that is required to make the individual indifferent between military and civilian life. It is a measure of the individual's net preference for civilian life. A positive value of δ means that the individual prefers the non-pecuniary aspects of civilian life to the non-pecuniary aspects of military life. We assume that δ is a constant over all prospective future horizons of military service.

If n is the relevant time horizon, then the individual will stay if $C_n > \sum_{j=1}^{n} \delta d^j$, or if $A_n > \delta$, where we define $A_n = C_n / \sum_{j=1}^{n} d^j$. That is, the individual will stay only if the cost of leaving exceeds the present value of his net preference for civilian life. The transformation from C_n to A_n reveals that the individual will stay only if his annualized cost of leaving (ACOL), denoted A_n, exceeds his annual net preference for civilian life.[7]

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7. In fact, the time horizon that is relevant is endogenous to the individual's decision-making process. In Appendix B, we demonstrate that the relevant value of n is the one for which A is maximized over the set $n=1,\ldots,n^*$. Empirically, the relevant

Relating ACOL to the Reenlistment Rate

The reenlistment rate r is the proportion of individuals for whom $A_n > \delta$. We assume that δ is distributed normally among the cohort of first-term decision-makers with mean μ and standard deviation σ. Thus, the reenlistment rate may be written as

$$r = P(A_n > \delta) = \int_{-\infty}^{\frac{A_n - \mu}{\sigma}} N(0,1)dz$$

where N(0,1) denotes a standard normal density and $z=(\delta - \mu)/\sigma$. The reenlistment function may be rewritten as

$$r = P(A_n > \delta) = \int_{-\infty}^{\beta_0 + \beta_1 A_n} N(0,1)dz$$

where $\beta_0 = -\frac{\mu}{\sigma}$ and $\beta_1 = 1/\sigma$, a specification which allows the use of probit analysis to estimate the parameters β_0 and β_1. Note that the effect on r of changes in military pay varies inversely with σ.

The Effect of Sea Duty on Reenlistments

We now explore the potential effect of sea duty on reenlistment supply. We examine the effect of sea duty on both the slope and location of the supply curve. Our analysis suggests that more sea duty serves to both reduce the elasticity of the supply curve and to shift it leftward.

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time horizon for the first-term reenlistment decision turns out

To analyze these effects, suppose that δ_1 is the distaste factor associated with sea duty and δ_2 is the distaste factor accociated with shore duty. Let π be the proportion of time the individual expects to spend in sea duty. Then the individual's distaste for service can be written as a weighted average of δ_1 and δ_2

$\delta = \pi\delta_1 + (1-\pi)\delta_2$. We assume that δ_1 and δ_2 are joint normal with mean vector $(\mu_1 \quad \mu_2)$, standard deviations $(\sigma_1 \quad \sigma_2)$, and correlation ρ between one's distaste for sea duty and one's distaste for shore duty. While we expect that that this correlation is positive, we think that its value is low. The mean of the distribution of δ is $\mu = \pi\mu_1 + (1-\pi)\mu_2$, and its variance, σ^2, is $\pi^2\sigma_1^2 + (1-\pi)^2\sigma_2^2 + 2\pi(1-\pi)\rho\sigma_1\sigma_2$.

First consider the effect of sea duty on the slope of the reenlistment supply curve. The effect depends on σ_1 and σ_2 , as well as upon π and ρ . Recall that in the probit model the slope parameter β_1 equals $1/\sigma$. Therefore, as σ^2 increases, the slope (and elasticity) of the supply curve diminish. Differentiating σ^2 with respect to π we find that

$\partial\sigma^2/\partial\pi = 2(\pi\sigma_1^2 - (1-\pi)\sigma_2^2 + (1-2\pi)\rho\sigma_1\sigma_2)$. An increase in π will lower β_1 if $\partial\sigma^2/\partial\pi > 0$. The final term in this expression will approach 0 as π approaches .5 or as ρ approaches 0. Ignoring this term, the sign of $\partial\sigma^2/\partial\pi$ will be the same as the sign of $\frac{\pi}{1-\pi} - \frac{\sigma_2^2}{\sigma_1^2}$. To evaluate this, note that π exceeds .5 for most ratings. Also, it is plausible that there is more dispersion in distastes for

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to be that of a 4 year reenlistment.

sea duty than in distastes for shore duty, that is, $\sigma_1^2 > \sigma_2^2$. It therefore seems reasonable to hypothesize that $\partial\sigma^2/\partial\pi > 0$, hence increases in π serve to reduce β_1 .

Next consider the effect of sea duty on the location of the supply curve. Recalling that $\mu = \pi\mu_1 + (1-\pi)\mu_2$ and that the constant term in the probit supply equation is $-\mu/\sigma$, the reenlistment supply equation may be written as

$$r = \int_{-\infty}^{\beta_0 + \beta_1 A_n + \beta_2 \pi} N(0,1)\, dz$$

where $\beta_0 = -\mu/\sigma$ and $\beta_2 = (\mu_2 - \mu_1)/\sigma$.

Since δ measures the distaste for service and since the distaste is likely to be stronger for sea duty than shore duty, it follows that $\mu_1 > \mu_2$. Hence β_2 is negative, and an increase in π serves to reduce r.

4. Empirical Analysis

Empirical Specification of the Model

Our theoretical model suggests that the probability of reenlisting is a function of the annualized cost of leaving. Based on our theoretical model, ACOL over any time horizon n can be written as

$$A_n = \frac{\left(\sum_{j=1}^{n} M_j d^j + \sum_{j=n+1}^{T} R_{jn} d^j\right)}{\sum_{j=1}^{n} d^j} - \frac{\left(\sum_{j=1}^{T} W_{j0} d^j - \sum_{j=n+1}^{T} W_{jn} d^j\right)}{\sum_{j=1}^{n} d^j}$$

The first right-hand side term is the annualized value of military pay plus retirement, the sum of which we label $\bar{M}_n$. The second right-hand side term is the annualized value of civilian earnings, accounting for the fact that n more periods of service may affect the person's civilian earnings capacity. We label this $\bar{W}n$. If the stream W_{jn} is the same as the last T-n elements of the stream W_{jo}, then additional military service has no net human capital effect and $\bar{W}_n$ will just be the annualized value of the first n elements of W_{j0} . If because of the specific nature of much military training, additional service detracts from one's civilian earnings capacity, then W_{jn} will lie below the last T-n elements of W_{jo} . $\bar{W}_n$ will thus reflect the human capital loss due to further military service. Evidence on the human capital effect of military service is limited.[8]

From this, one specification of the model would be to compute $\bar{M}_n$ and $\bar{W}_n$ and enter the difference $A_n = \bar{M}_n - \bar{W}_n$ as the pay variable in the estimation procedure. External estimates of W_{j0} for different groups of personnel are available in Ross and Warner(1976). They estimated post-service earnings profiles for a cohort of personnel who left after one term of service in FY 1969. Earnings profiles were found to vary significantly by race, education level, mental group as measured from military entry test scores, and military occupation group. For personnel dimensioned by these various attributes, these estimated earnings functions were used to predict their earnings profiles from leaving after

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8. For some evidence, see Cooper(1981), Raduchel, et. al.(1978), and Ross and Warner(1976).

the first term. An implied assumption in our procedure is that there is no net human capital effect of continued military service. Since the time horizon n in our calculation of A_n for each person is only the period of reenlistment, this assumption seems innocuous.

The main disadvantage of this approach is that estimates of A_n will be biased to the extent that there is measurement error in $\bar{W}_n$. On the other hand, this procedure has the advantage that the variable A_n will capture variation across individuals in $\bar{W}_n$ as well as $\bar{M}_n$. Thus, even the occupation groups where there was no significant variation in $\bar{M}_n$ during the sample period, there will be enough variation in A_n to obtain a meaningful estimate of β_1.

Instead of calculating A_n for each individual from external estimates of $\bar{W}_n$, an alternative approach is as follows. Suppose that $\bar{W}_n$ is equal to

$$\alpha_0 + \sum_{i=1}^{k} \alpha_i x_i$$

where the x's represent variables for education level, mental group, and race. Then A_n may be written as $\bar{M}_n - \alpha_0 - \sum_{i=1}^{k} \alpha_i x_i$

and the reenlistment equation may be written as

$$r = \int_{-\infty}^{(\beta_0 - \beta_1\alpha_0) + \beta_1 \bar{M}_n - \sum_{i=1}^{k} \beta_1\alpha_i x_i} N(0,1)\,dz$$

This is a reduced form equation in $\bar{M}_n$ and the determinants of $\bar{W}_n$. The primary advantage of this method is that the esti-

mates of β_1 are less likely to be biased than in the first specification, since there will presumably be less measurement error in M_n than W_n. (We can measure military earnings quite accurately.) Although bias in the estimation of β_1 is less likely, the primary disadvantage of this procedure is that it does not utilize all of the available variation across individuals in A_n. Again, in occupation groups where the variation in $\bar{M}_n$ is low, this specification will not yield meaningful estimates of β_1.

Reenlistment equations were estimated using both specifications. In general, both specifications tended to yield the same pattern of results. Occupation groups that had a high (low) estimate of by one specification had a high (low) estimate by the other specification. The weighted correlation between the estimates for the different groups, where the weights are the per centage of the sample in each occupation group, is +.72. Overall, we prefer the results from the first specification for two reasons. First, the estimates of β_1 by the first specification in general were larger and more in line with estimates from previous studies. Second, the dispersion across occupation groups in the estimates was smaller, and the pattern of estimates appeared more consistent. Thus, we proceed to present the estimates from the first specification without attempting a detailed comparison between specifications.

Pay Responsiveness of Different Occupation Groups

Table 4 shows the estimates of β_1 for the first specification of the model. Also shown in the table are the estimated pay

TABLE 4

ESTIMATES OF β_1, THE FIRST-TERM PAY ELASTICITY (E), AND THE EFFECT OF A ONE LEVEL INCREASE IN SRB

	β_1	E	Δ_r
SHIP MAINTENANCE	.000200 (8.02)[a]	2.12	.023
HEALTH CARE	.000265(21.13)	2.91	.033
LOGISTICS	.000325(31.47)	3.25	.055
MARINE ENGINEERING	.000172(14.38)	1.86	.023
WEAPONS SYSTEMS/CONTROL	.000236(17.53)	2.46	.034
AVIATION MAINTENANCE	.000231(32.99)	2.46	.032
CONSTRUCTION	.000288(16.58)	3.42	.026
ADMINISTRATION	.000252 (2.44)	2.44	.042
SHIP OPERATIONS	.000026 (1.06)	----	----
COMMUNICATIONS	.000177(13.73)	1.86	.025
AVIATION GROUND SUPPORT	.000236(15.60)	2.46	.034
DATA SYSTEMS	.000241 (9.16)	2.41	.038
GENERAL SEAMANSHIP	.000216(17.38)	2.30	.030
ORDNANCE	.000121 (6.38)	1.06	.022
CRYPTOLOGY	.000285(14.91)	2.59	.051
MEDIA	.000172 (7.43)	1.99	.018
WEIGHTED AVERAGE	.000211	2.35	.032

[a] t values in parenetheses.

elasticity (percent increase in r for a one percent increase in second-term military pay) and the estimated effect on r of a one level increase in SRB.

The first conclusion we reach is that variation in A_n explains much of the variation in the probability of reenlisting. With one exception, the estimates of β_1 are all positive and highly statistically significant. The weighted average pay elasticity calculated from our estimates of β_1, 2.35, is quite consistent with estimates from previous studies. (See Enns(1977, table D-1) for a review.)

The second conclusion we reach is that the estimates of do indeed vary with the extent of sea duty. Ignoring the statistically insignificant estimate for the Ship Operations group, the weighted correlation between β_1 and the percentage of careerists in sea duty is -.49. This correlation is statistically significant at the .06 level. While the correlation is not perfect, it supports the hypothesis that reenlistment supply curves are less elastic in occupations characterized by a high amount of sea duty.

The estimated effect of a one level increase in the SRB is shown in the righthand column of table 4. These calculations were made using FY1978 reenlistment rate as the base. Since the reenlistment supply function is nonlinear, the estimated Δr depends on the level of r. We estimate that, beginning with 1978 values of r, a one level bonus increase will raise r by between .018 and .055, with a weighted average estimate of .032. That

is, on the average, each one multiple increase will generate 3.2 reenlistments per 100 persons eligible to reenlist.

How well do these estimates predict the effect of bonus changes? At the aggregate level, they predict quite well. Between 1978 and 1979, 53 Navy ratings suffered a reduction in reenlistment bonuses, while no rating experienced an increase.[9] Between 1978 and 1979 reenlistment rates fell, but they fell by .045 more in those ratings experiencing a bonus reduction than in those ratings experiencing no change. Between 1979 and 1980, 8 ratings experienced a bonus reduction. The reenlistment rate in these ratings fell by .030 relative to the 1979-80 change in those ratings experiencing no bonus change. Our average estimate of the effect of a bonus change, .032, is bounded by these 1978-79 and 1979-80 average changes. The data are not yet sufficient to validate our predictions for individual occupation groups, but we will do so as the data do become available.

The Impact of Other Factors

In the first specification of the model, other variables included were the individual's marital status and the civilian unemployment rate at the time of reenlistment. Married individuals were found to reenlist at a higher rate than single persons, and this effect was quite stable across occupation groups. These

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9. These bonus reductions came as a result of elimination of the regular reenlistment bonus (RRB) program. This program, which gave a level one bonus to all reenlistees, was eliminated in 1974, but a "save pay" provision awarded a level one bonus to all reenlistees in non-SRB ratings who entered service prior to 30 june 1974. Most of these individuals reached the end of their first term of service by June 1978.

results are indicative of the fact that military non-pecuniary benefits, principally medical benefits, are of greater value to married persons than single persons. The estimated impact of civilian unemployment was less stable, being positive and statistically significant in only 8 of 16 equations. Of the significant estimates, the average elasticity between r and civilian unemployment was +.5.

The Location Effect of Sea Duty

Our theory suggests that sea duty serves to shift the supply curve as well as alter its slope. Because of the lack of variation in the extent of sea duty within occupation groups, we could not test for a location effect in our time series analysis. We can do so, however, in a cross-section analysis. To do this, we estimated a probit equation utilizing data on all of the first-term personnel making reenlistment decisions in FY1979. The sea duty variable included in this analysis is the proportion of personnel in the individual's rating who are in sea duty in the 4 LOS cells following the individual's LOS cell at the time of his decision. This proportion is a proxy for individual's expected proportion of sea time during another term of enlistment. Other variables in this analysis include various background variables previously used, the annualized value of military pay over the horizon of a reenlistment, and military occupation group dummies (to standardize for differences in civilian opportunities due to differences in military training).

Table 5 reports the estimated effect of sea duty. The estimated effect of sea duty is negative and highly statistically significant. At the sample means, we estimate that a 10 percent increase in the extent of sea time during the second term of service will reduce r by .016. The elasticity of r with respect to sea duty ($\%\Delta r/\%\Delta s$) is -.34. Rating groups for which the extent of sea time during the second-term exceeds 70 percent will have a reenlistment rate that is around 5 percentage points lower than rating groups where the extent of sea time is between 40 and 50 percent.

While sea duty has a negative effect on the first-term reenlistment rate, it appears that its adverse effects are readily controlled by bonuses. Even in occupation groups where the retention effect of bonuses is low, the estimated effect of a one multiple SRB change outweighs the effect of a 10 percent increase in the extent of second-term sea duty.

These results have some important policy implications. The Navy's first priority is to man ships as close to "requirements" as possible. Recently some ships have been tied up due to lack of personnel to man them. At least in rating groups where the extent of sea duty is not already very high, our results suggest that the Navy may increase ship manning more cheaply by raising bonsues and increasing the extent of sea time than by holding constant (or lowering) sea time and raising the total size of the Navy.

5. Conclusions

TABLE 5

ESTIMATED EFFECT OF SEA DUTY

Coefficient And t Value	Effect Of A 10 Percent Increase In Sea Time During Second-Term	Elasticity
-.765 (15.21)	-.016	-.34

This paper has developed and estimated a model of the first-term reenlistment decisions of Navy enlisted personnel. Our results suggest that sea duty exerts a significant influence on the reenlistment supply functions of Navy enlisted personnel. Additional sea duty serves both to reduce the elasticity of the reenlistment supply function and to shift it leftward. Our results have significant implications for the management of the Navy's reenlistment bonus program as well as for other compensation and personnel policies.

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Appendix A

This appendix shows the two-letter Navy ratings in each of the 16 occupation groups. in our analysis. Some of the two-letter ratings listed below may be broken down into detailed three-letter ratings, although that is not done here.

1. Ship Maintenance: Hull Technician (HT), Machinery Repairman (MR), Molder (ML), Patternmaker (PM), Instrument Man (IM), Optical Man (OM)
2. Health Care: Hospital Corpsman (HM), Dental Technician (DT)
3. Logistics: Storekeeper (SK), Aviation Storekeeper (AK), Disbursing Clerk (DK), Mess Management Specialist (MS)
4. Marine Engineerning: Machinist Mate (MM), Boiler Technician (BT), Engine man (EN), Electrician's Mate (EM), Interior Communications Electrician (IC)
5. Weapons Systems/Control: Electronics Technician (ET), Fire Control Technician (FT)
6. Aviation Maintenance: Aviation Electronics Technician (AT), Aviation Electrician (AE), Aviation Machinist (AD), Aviation Ordnance Man (AO), Aviation Mechanic (AM), Air Traffic Controller (AC), Aviation ASW Technician (AX), Aviation Fire Control Tech. (AQ), Avionics Technician (AV)
7. Construction: Builder (BU), Construction Electrician (CE), Construction man (CN), Engineering Aide (EA), Equipment Operator (EO), Steelworker (SW), Utilitiesman (UT),
8. Administration: Legalman (LM), Navy Councilor (NC), Personnel Man (PN), Postal Clerk (PC), Yeoman (YM)
9. Ship Operations: Operations Specialist (OS), Quartermaster (QM)
10. Communications/Sensor Systems: Radarman (RM), Electronic Warfare Technician, (EW), Sonar Technician (ST), Ocean Systems Technician (OT), Aviation Electronic Warfare Technican (AW)
11. Aviation Ground Support: Aviation Boatswain's Mate (AB), Aviation Support Technician (AS), Parachute Rigger (PR)
12. Data Systems: Data Systems Technician (DS), Data Processor (DP)
13. General Seamanship: Boatswain's Mate (BM), Signalman (SM)
14. Ordanance: Gunner's Mate (GM), Mineman (MN), Missile Technician (MT), Torpedoman (TM)
15. Cryptology: Cryptologist (CT), Intelligence Specialist (IS)
16. Media: Photographer (PH), Journalist (JO), Librarian (LI), Lithographer (LI), Musician (MU)

Appendix B

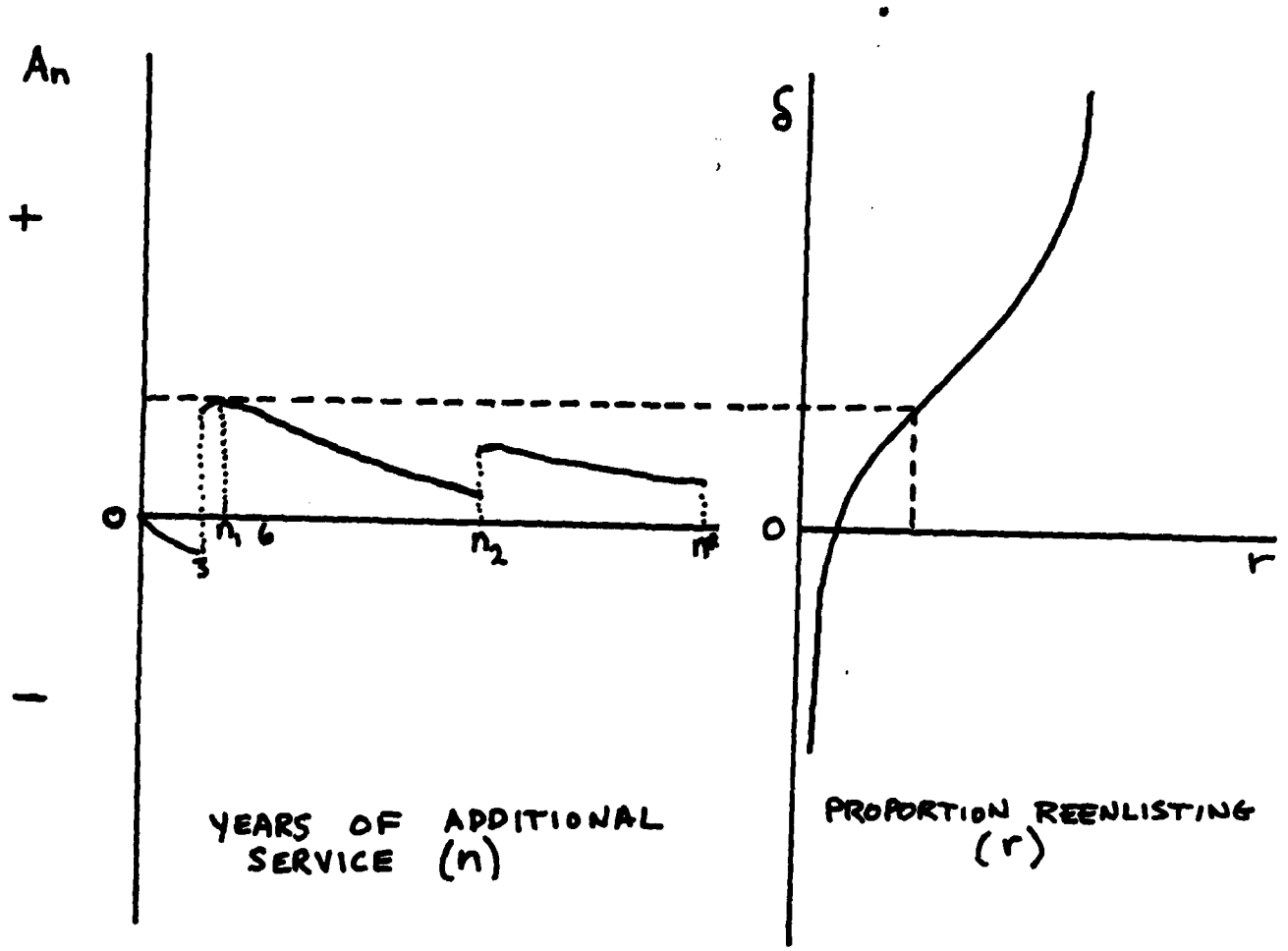
Derivation of the Time Horizon Relevant for Reenlistment Decisions

The individual prefers a strategy of staying n more years and then leaving to one of leaving immediately if and only if $C_n > \sum_{j=1}^{n} \delta d^j$, or $A_n > \delta$, where $A_n = C_n / \sum_{j=1}^{n} d^j$. The individual will leave if and only if the strategy of leaving immediately is preferred to any strategy that involves staying, or $A_n < \delta$ for all $n=1,\ldots,n^*$. This is equivalent to the condition $\text{Max } A_n < \delta$. The individual will stay if and only if this condition is false, or $\text{Max } A_n > \delta$. Hence the relevant ACOL value for decision-making is the maximum value over the set $(A_1,\ldots,A_{n^*})$, and the relevant time horizon for computing ACOL is the one over which the ACOL value is maximized.

The left-hand panel of Figure 1 plots a typical pattern of ACOL values over various time horizons for personnel facing a first-term reenlistment decision. The right-hand panel plots values of δ on the vertical axis and the cumulative probability density of δ (i.e., the reenlistment rate r) on the horizontal axis.

Note some interesting features of the first-term reenlistment decision. Because of the fact that bonuses are concentrated at the first-term reenlistment point and because first-term personnel appear to exhibit high discount rates,[10] the maximum ACOL value is usually found within the period of a reenlistment (horizon n_1 in Figure 1). ACOL values decline between the length of a

10. The interested reader is referred to Gilman(1976). From Gilman's results, we predict that first-term personnel have real annual discount rates between 15 and 20 percent.


An
+
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n_2
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0
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YEARS OF ADDITIONAL SERVICE (n)
PROPORTION REENLISTING (r)

FIGURE 1

first reenlistment and LOS 20, because later bonuses are lower than first-term bonuses and because RMC falls short of civilian earnings after about 8 years of service. Because of retirement vesting, ACOL values rise again at LOS 20. Yet ACOL over this horizon usually does not rise as high as ACOL over the period of a first reenlisment (hence the justification for using ACOL values over the horizon of a reenlistment in the empirical analysis).

A strong implication of the ACOL model is that a simple reduction in 20-year retirement benefits would have no effect on the first-term reenlistment rate, although reenlistment rates at later terms would be affected. For analyses of the effects of recently proposed changes to the military retirement system, see Warner(1979,1981).

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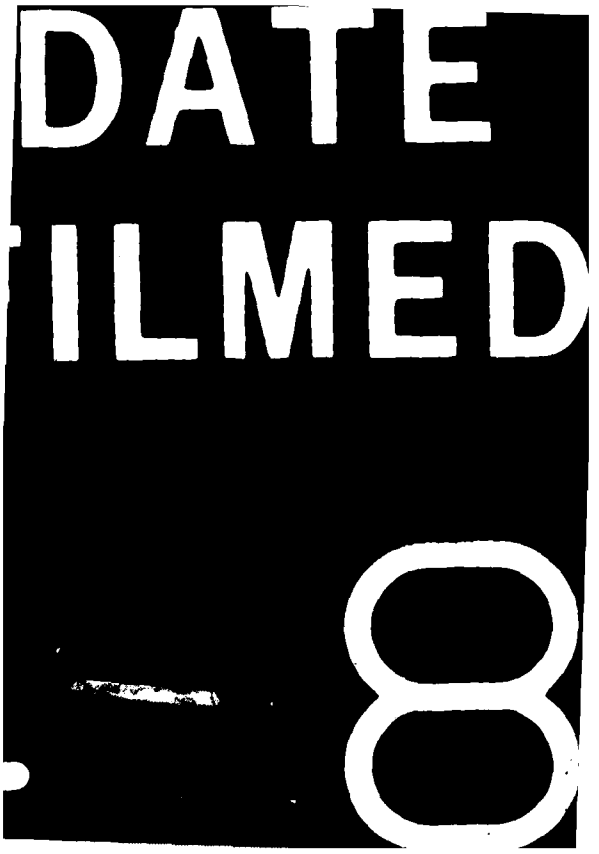
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