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1. Enclosure (1) is forwarded as a matter of possible interest.

2. This Research Memorandum analyzes the effects of reserve pay and individual characteristics on the retention of Navy veterans in the Selected Reserve. The estimates show that pay has a significant positive impact on first-year continuation rates in 7 of 11 rating groups. The analysis highlights the need to understand differences in retention among ratings in order to allocate bonus funds effectively.

Robert F. Lockman

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Sixth Quadrennial Review of Military Compensation

CRM 88-72 / May 1988

RETENTION OF NAVY VETERANS IN THE SELECTED RESERVE

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ABSTRACT

This analysis develops and estimates a model of retention during the first year of affiliation in the Selected Reserve. Estimates of the effects of pay and personal characteristics are provided for 11 Navy rating groups. The results should be useful for forecasting Selected Reserve manpower levels and for evaluating the effects of affiliation and retention bonuses.

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INTRODUCTION

Because of increased emphasis on the importance and value of reserve forces, planners have recently focused their attention on effective ways to meet reserve manpower requirements. To meet required force structures at minimum cost, manpower planners make great use of targeted enlistment and retention bonuses. A previous Center for Naval Analyses (CNA) study analyzed the effectiveness of bonuses on affiliation [1]. This study concentrates on retention and develops and analyzes a model of retention for reservists in the Navy Selected Reserve, complementing the previous affiliation analysis.

The study focuses on the retention behavior of Navy veterans because they are the largest single source of manpower for the Naval Reserve. Veterans are also generally the preferred source of manpower for the Selected Reserve, having already obtained valuable training and experience while on active duty. The available data on veterans is better and more prevalent, and most of the bonus programs in the reserves are designed for attracting veterans. Focusing on veterans also provides a useful comparison to the existing studies of affiliation.

In keeping with the objectives of the Sixth Quadrennial Review of Military Compensation, this analysis concentrates on estimating the effects of pay on retention. Factors such as patriotism, training opportunities, and leadership are not explicitly addressed, although they clearly are important. The statistical analysis necessarily focuses on the quantifiable aspects of retention, such as pay and personal characteristics.

AN EMPIRICAL MODEL OF RETENTION

The model developed and estimated in this study closely follows the analysis of affiliation decisions in the earlier study by Shiells [1]. Models of reenlistment, such as those of Goldberg and Warner [2], are inappropriate for studying reserve retention because there is no clear-cut reenlistment point. Although veterans affiliating with the Selected Reserve sign contracts, attrition from the reserves shows little relationship to formal contract expiration dates. This lack of relationship occurs because the association with the reserve is voluntary, and although the contracts are legally binding, in practice there is rarely punishment for those who fail to fulfill them. Because there is no relevant reenlistment point for studying reserve retention, the approach used in this study was to examine the probability of persons remaining in the Selected Reserve for a specified period of time. Because retention is generally lowest during the first year in the reserves, a logical starting point was to analyze the determinants of retention during the first year. Alternative approaches using different time periods or based on the total length of time in the

reserves (i.e., survival analysis of the length of service in SELRES) are not analyzed here but are being explored in other CNA studies.

The model is developed in terms of the utility, or value, that the individual places on service in the Naval Reserve versus alternative uses of his time. Once the reservist has decided to affiliate, the options are to remain in SELRES during the next year, or leave sometime during that year. To simplify the exposition of the model, it is assumed that the utility obtained from reserve association during the year can be expressed as:

$$V_S = \alpha W_S + \delta_S \ , \tag{1}$$

where W_S is the financial return from reserve duty and δ_S represents the monetary equivalent of the nonpecuniary benefits from belonging to the reserves. The coefficient α on W_S acts to weight the pecuniary and nonpecuniary components of utility. Similarly, the utility from leaving SELRES is expressed as:

$$V_L = \alpha W_L + \delta_L \tag{2}$$

The subscripts S and L refer to those staying for the full year and those leaving, respectively. The specification explicitly leaves open the possibility that participation in the reserves may have an impact on an individual's civilian earnings, as well as result in different nonpecuniary benefits. The impact on civilian pay is allowed to account for the possibility that reserve obligations may interfere with civilian employment, such as the occasional need to forego overtime, travel, or other obligations.

The nonpecuniary benefits are assumed to be specified as:

$$\delta_S = \alpha_S^0 + \alpha_S^1 z + \gamma_S \quad \text{and} \tag{3}$$

$$\delta_L = \alpha_L^0 + \alpha_L^1 z + \gamma_L \ , \tag{4}$$

where z is a vector of personal and job characteristics that affect utility, and γ_S and γ_L are unobserved random effects, such as patriotism, civilian employment opportunities, and other nonquantifiable factors.

An individual will stay in the reserves for the full year if $V_S > V_L$, that is, if the utility from staying exceeds the utility from leaving. Put differently, the individual stays if

$$\gamma_S - \gamma_L > \alpha(W_L - W_S) + (\alpha_L^0 - \alpha_S^0) + (\alpha_L^1 - \alpha_S^1)\, z > 0 \ . \tag{5}$$

Let P_S be the probability that an individual stays in the Selected Reserve for at least one year. If $\gamma_S - \gamma_L$ is assumed to have

a logistic cumulative distribution function, the probability of staying one year is obtained from

$$\log\left(\frac{P_S}{1 - P_S}\right) = \beta_0 + \beta_1(W_S - W_L) + \beta_2 Z \ , \qquad (6)$$

where the β_i coefficients are transformations of the α_i coefficients above.

Note that in this specification, there is no differentiation between reserve pay that comes from drill pay and reserve pay that comes from a bonus. It is assumed that, from the viewpoint of the individual reservist, one dollar is worth one dollar regardless of what it is named. This approach is consistent with common sense and yields more precise estimates of pay effects. Because data on the civilian earnings of each reservist are not available, $(W_S - W_L)$ is assumed to be equal to reserve pay.

DATA AND SPECIFICATION OF VARIABLES

The sample used in the analysis consists of Navy veterans who separated from active duty in fiscal years 1981 through 1985. Only first-term veterans are included, and all must have been eligible for reenlistment. Separations were identified from the Enlisted Master Record, along with personal characteristics and military records, such as rating, paygrade, and reenlistment eligibility. Enlistment and retention data were obtained from the Reserve Common Components Personnel Data System (RCCPDS). Information on bonus eligibility is provided from the series of Reserve Recruiting and Manning Objective System (RAMOS) instructions used by Commander, Naval Reserve Force, to set enlistment goals and rating categories. Bonus eligibility is determined by an individual's rating and length of service, and the list of bonus ratings is regularly updated. Consequently, individuals with the same rating and length of service but different separation dates may not necessarily have the same calculated reserve pay.

As discussed above, the reserve pay variable used consists of the sum of drill pay and any affiliation bonus that the reservist qualifies for. It is important to note that the imputed bonus pay is based on whether an individual qualifies for a bonus, not whether a bonus is actually received. For most of the sample period, there is insufficient data to determine which reservists actually receive bonuses. This indeterminancy may cause the estimated effect of pay to be understated.

The personal characteristics used in the analysis to control for differences in civilian opportunities and tastes for the military are sex, race, education, paygrade, and marital status. The analysis by Sniells [1] found that women and nonwhites were more likely to affiliate. It is possible that these behavioral differences may also affect retention, so controls for sex and race are included. Many studies of

attrition in the military have found significant differences in retention between high school graduates and nongraduates, and a dummy variable is included to estimate this impact. Variables are also included to examine the data for retention differences by marital status.

Paygrade differences may also affect retention. Higher paygrade reservists may be more likely to remain because they have demonstrated more ability or interest in Navy service. Inclusion of the paygrade may make it more difficult to estimate the effects of pay, however, due to the high correlation between paygrade and drill pay. For that reason, a variable for length of service is also not included, which is reasonably approximated by paygrade anyway.

Many reservists join the Selected Reserve while on active duty, while others do not enlist for several months. The retention behavior between these two groups may differ, if, for example, those who are out for an extended period of time consider their affiliation decision more carefully. Conversely, those joining immediately after separation may be more dedicated or eager to join, which would imply higher continuation rates. A variable, time since separation, is included to estimate whether differences in this length of time affect retention.

Although they are clearly important, the effects of duty assignment variables on retention cannot be estimated with the data available for this study. Incorporating duty variables, such as whether an individual is cross-assigned or In Assignment Processing (IAP, or not in a mobilization billet), introduces a bias into the estimates because this information is available only after a reservist has been in SELRES for a period of time. Hence, the variables tend to have positive estimates, even if the true impact is otherwise.

The Naval Reserve includes a large number of ratings among which retention behavior may differ. To examine these differences, the Navy ratings are segmented into 11 occupational groupings, each of which is estimated separately. This allows for variations in the effects of pay and other variables on retention. There is little reason to expect that hospital corpsmen (HM), for example, will respond the same way to pay changes as builders (BU) or seamen (SN). Table 1 lists the occupational groups used in the analysis, along with the ratings included in each. Sample characteristics by rating group are provided in table 2.

TABLE 1

RATING GROUPS BY ONE-DIGIT OCCUPATIONAL CATEGORY

1	Seamanship	BM, GMG, QM
2	Electronic equipment repair	AQ, AT, AX, CTM, DS, ET, FT, MT, ST, TD, TM
3	Communications/intelligence	AC, AW, CTI, CTO, CTR, CTT, EW, IS, OS, OT, RM, SM
4	Medical	DT, HM
5	Other technical	AG, DM, EA, MU, PH
6	Administrative/clerical	AK, AZ, CTA, DK, DP, JO, PC, PN, RP, SK, YN
7A	Mechanical equipment repair--aviation	AB, AD, AE, AM, AO, AS
7S	Mechanical equipment repair--surface	BT, CM, EM, EN, GMM, GMT, GS, IC, IM, MM, MN, OM
8	Craftsmen	BU, CE, EO, HT, LI, ML, MR, PM, SW, UT
9	Service/supply	MS, PR, SH
10	Unrated	AN, CN, FN, SN

As can be seen in table 2, there is substantial variation in the average first-year continuation rate among the rating groups in the sample.. The highest retention group is Group 4, which consists of the medical ratings; the lowest retention is in Group 7A, mechanical equipment repair--aviation. The rating groups also vary considerably in their typical demographic characteristics. Non-high-school graduates are common within the nonrated category (Group 10) and least likely in the medical field (Group 4).

ESTIMATION RESULTS

The maximum likelihood estimates for all rating groups are shown in table 3. The estimates show that pay has a significant positive effect in 7 of the 11 rating groups. The rating groups that do not show a statistically significant effect from pay variables are medical (Group 4), mechanical equipment repair-aviation (Group 7A), service and supply (Group 9), and unrated (Group 10). Possible reasons for the lack of an estimated pay effect for these rating groups are the limited variation in pay within each group (especially in the unrated group, in which all personnel are in paygrade E-3 and receive no bonuses) and actual behavioral differences.

The most important variables affecting first-year retention are pay and education. Non-high-school graduates are significantly less likely to complete the first year of reserve duty than are graduates.

TABLE 2

DESCRIPTIVE STATISTICS BY RATING GROUP

	1	2	3	4	5	6	7A	7S	8	9	10
Number of observations	1,883	2,387	3,653	3,129	409	2,997	3,206	7,113	1,960	1,112	1,189
Continuation rate (percent)	49.7	59.8	54.3	61.5	58.9	55.2	47.8	51.4	50.4	53.8	49.9
Average paygrade	4.3	4.8	4.6	4.2	4.5	4.4	4.3	4.4	4.6	4.1	3.0
Average pay (thousands of 1986 dollars)	2.1	2.1	2.1	2.1	2.1	2.0	1.9	1.9	2.1	2.0	1.7
Percent nonwhite	17.5	9.7	19.5	19.0	10.3	25.5	24.6	19.4	8.7	25.3	35.4
Percent female	4.0	6.4	16.7	30.0	35.9	42.9	6.0	4.0	3.7	17.2	10.3
Percent nongraduate	23.7	9.3	11.1	7.9	8.1	11.0	15.2	14.8	15.1	15.2	24.7
Percent married	31.7	31.6	28.9	37.5	35.7	37.2	31.4	31.1	33.8	32.3	26.7
Average time since affiliation (months)	8.1	8.7	7.2	6.0	7.7	8.1	9.0	9.0	9.1	8.8	8.8

TABLE 3

MAXIMUM LIKELIHOOD ESTIMATES FOR RATING GROUPS 1-10[a]

	1	2	3	4	5	6	7A	7S	8	9	10
Intercept	-1.997	-2.129	-2.082	-0.680	-2.269	-1.056	-1.196	-2.054	-2.394	-0.976	0.841
	(4.02)	(4.83)	(5.88)	(1.64)	(2.28)	(2.54)	(2.64)	(7.38)	(4.86)	(1.40)	(0.56)
Nonwhite	0.379	0.058	0.130	0.070	-0.123	-0.014	0.090	0.176	0.083	0.091	0.113
	(3.02)	(0.40)	(1.48)	(0.73)	(0.36)	(0.16)	(1.06)	(2.83)	(0.50)	(0.63)	(0.89)
Nongraduate	-0.419	-0.770	-0.502	-0.594	-0.756	-0.499	-0.473	-0.587	-0.582	-0.777	-0.677
	(3.66)	(5.22)	(4.57)	(4.39)	(1.96)	(4.12)	(4.56)	(8.29)	(4.32)	(4.29)	(4.75)
Female	0.220	0.352	0.565	0.271	0.649	0.314	0.389	0.339	0.519	0.515	0.003
	(0.91)	(1.96)	(5.94)	(3.22)	(2.86)	(4.01)	(2.55)	(2.73)	(2.07)	(3.01)	(0.01)
Pay	1.774	2.439	1.644	-0.268	3.964	1.639	-0.138	1.695	2.142	0.095	-1.878
	(2.29)	(2.75)	(3.00)	(0.43)	(1.97)	(2.31)	(0.14)	(2.76)	(2.72)	(0.08)	(0.65)
Paygrade	0.181	0.186	0.216	0.286	0.022	-0.009	0.234	0.214	0.193	0.199	--[b]
	(2.24)	(2.47)	(3.49)	(4.36)	(0.11)	(0.13)	(3.26)	(4.43)	(2.32)	(1.69)	
Married	-0.194	-0.068	-0.025	-0.021	-0.258	0.034	-0.101	-0.096	-0.136	-0.057	0.065
	(1.97)	(0.73)	(0.33)	(0.27)	(1.15)	(0.43)	(1.30)	(1.83)	(1.57)	(0.43)	(0.48)
Time since separation	0.021	0.020	0.023	0.013	0.038	0.027	0.026	0.027	0.032	0.033	0.027
	(4.70)	(5.17)	(6.57)	(3.27)	(3.44)	(7.21)	(8.20)	(12.12)	(7.33)	(5.46)	(4.66)
Log likelihood	-1,271	-1,557	-2,447	-2,054	-263	-2,016	-2,163	-4,766	-1,308	-735	-801
Chi-square	67.5	102.6	143.0	63.9	27.6	89.1	112.5	322.7	101.9	64.8	46.0
Observations	1,883	2,387	3,653	3,129	409	2,997	3,206	7,113	1,960	1,112	1,189

a. Absolute value of t-statistic is in parentheses. The chi-square statistic is a test of the joint significance of the explanatory variables.

b. A dash indicates that the variable was not included in the equation.

Although this result is similar to that found in active duty studies of attrition,[1] it is nonetheless surprising that the effect remains so strong even after the sailor has successfully completed an active duty tour. (Note also that the sample includes only those eligible for reenlistment.) This analysis confirms previous findings that nongraduates are generally much less reliable recruits than graduates.

The effects of the other variables are generally mixed, with the estimates varying among rating groups. In most cases, higher paygrade results in higher continuation, even after controlling for the pecuniary effects of paygrade via the pay variable. Apparently, individuals leaving active duty with higher paygrades are better adapted to Navy life or have a significantly stronger preference for military service.

Sex also has a fairly strong effect in many rating groups, with women having higher continuation rates than men. Marital status, however, has little impact, indicating that the burden that reserve duty places on family life is not much greater for married people. There is little difference in continuation rates between whites and nonwhites in this sample. Delays between separation from active duty and reserve affiliation generally improve retention, perhaps because the reservist has spent more time thinking about the enlistment decision. Although always positive and statistically significant, the effect is relatively small. The estimated effect of time since affiliation indicates that it acts much like the Delayed Entry Program (DEP) does in active Navy recruiting--recruits who were in the DEP prior to accessing are less likely to leave.

The impact of pay on retention is best shown in table 4, which gives the predicted effect on continuation rates of a $300 bonus. For most of the rating groups, the impact is sizable, with predicted continuation rising by several points.[2]

The estimated effects of pay shown in table 4 actually underestimate to a large degree the net effect of a bonus on SELRES manpower. The bonuses used by the Naval Reserve are actually affiliation bonuses, although, as this analysis has shown, they also affect retention. To evaluate the true effect of an affiliation bonus, the cumulative effects of the bonus on both affiliation and retention must be taken into account. For example, this analysis of retention indicated that attrition of hospital corpsmen (in rating group 4) was unaffected by pay. However, previous CNA research showed that rating group to have affiliation rates that were strongly affected by pay [1]. Focusing solely on

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1. See, for example, [3]. For an analysis of attrition in the Selected Marine Corps Reserve, see [4].
2. The standard errors of the predicted probabilities were calculated using the delta method described in [5].

retention or affiliation may provide a misleading picture of the total effect of a bonus on achieving manpower goals.

TABLE 4

PREDICTED EFFECT OF A $300 BONUS[a]

Rating group	Average continuation rate without bonus	Continuation rate with bonus
1	49.7 (1.2)	53.7 (2.1)
2	60.2 (1.0)	65.4 (2.1)
3	54.5 (0.8)	58.2 (1.5)
5	59.7 (2.5)	68.0 (4.7)
6	55.4 (0.9)	59.1 (1.8)
7S	51.5 (0.6)	55.3 (1.5)
8	50.5 (1.2)	55.4 (2.1)

a. Standard errors in parentheses were computed using the delta method.

A more complete description of the effect of a $300 bonus is provided in table 5. The table shows the estimated impact of a $300 bonus on the affiliation and retention rates of a notional group of 100 Navy veterans coming off active duty. The predicted effect of the bonus on affiliation and retention is shown for each rating group. As the table shows, there is substantial variation among rating groups due to differential responses to the bonus at affiliation time and differential responses to the bonus on retention. The rating groups also vary significantly in their average, or baseline, affiliation and continuation rates. For the medical rating group 4, for example, a bonus strongly affects affiliation but has little effect on retention. The large number remaining after one year is attributable to the high baseline affiliation rate and the response of affiliation to the bonus. Rating group 5

shows no effect of the bonus on affiliation but shows a positive effect on retention. Rating groups 9 and 10, on the other hand, are insensitive to pay during both the affiliation and retention decisions.

TABLE 5

EFFECTS OF A $300 BONUS ON AFFILIATION AND RETENTION

	Number affiliating		Number remaining one year	
Rating group	Without bonus	With bonus	Without bonus	With bonus
1	13	17	6.5	9.1
2	8	9	4.8	5.9
3	14	17	7.6	9.9
4	22	27	13.6	16.7
5	11	11	6.6	7.5
6	11	16	6.1	9.5
7A	10	10	4.8	4.8
7S	6	6	3.1	3.3
8	10	11	5.1	6.1
9	12	12	6.5	6.5
10	10	10	5.0	5.0

NOTE: Numbers refer to those remaining out of a hypothetical population of 100 Navy veterans. The effect of the bonus on affiliation is taken from [1], table 8, page 28.

The best indicator of the net effect of the bonus is provided by comparing the last two columns of table 5. These columns show the number of reservists left in SELRES out of a cohort of 100 veterans coming off active duty. The difference between the two columns gives the estimate of the cumulative impact of the bonus on the number of reservists who remain in SELRES one year after affiliation. For example, in Group 1, 13 out of 100 veterans coming off active duty would affiliate without the $300 bonus and 17 would join with it. Of those joining, approximately 6.5 would remain in SELRES after one year without

a bonus and 9.1 would remain if there were a bonus. One way to interpret these results is to say that the Navy gets about two-and-a-half more sailors with one year of experience for a hypothetical $300 affiliation bonus program for Group 1.[1]

These estimates may be used to calculate the additional costs of acquiring more Navy veterans. To use the example of Group 1, the Selected Reserve got 4 more affiliations than they would have without the bonus, and an expected 2.6 more veterans with one year of SELRES experience. The total cost for this added manpower is approximately $5,100 (17 affiliations times the $300 bonus). If the goal is to have reservists with skills and at least one year of experience in SELRES, the average cost for the extra manpower is $1,961 ($5,100 divided by the 2.6 gained in retention). In setting policy, this cost estimate should be compared to the benefits of readiness or the cost of getting the manpower from some other source. For example, if there are not enough Navy veterans, it may be necessary to recruit and train Sea and Air Mariners (SAMs) to fill the shortfall. If the recruiting and training costs for a SAM were greater than $1,960, it is more cost effective to use the bonus to attract Navy veterans. Because veterans are generally much better trained and qualified than SAMs, the overall benefit to the reserve forces is actually much greater due to the enhanced readiness of the units.

CONCLUSIONS

This study has developed and estimated a model of retention of Navy veterans during the first year of duty in the Selected Reserve. The results show that pay significantly affects retention. The strength of the effect, however, varies by rating group For ratings responsive to pay, affiliation and retention bonuses can be effective and relatively inexpensive tools for increasing retention. For ratings unresponsive to pay (the medical, service/supply, mechanical equipment repair-aviation, and unrated rating groups in this study), other mechanisms are needed. One method, already used in the medical ratings, is to recruit non-prior-service personnel (NPS) instead of Navy veterans. NPS recruits have a mandatory drilling obligation, which results in higher retention. The lack of a pay effect for the unrated group is probably due to greater importance of promotion and training opportunities for this category.

The results of this analysis also showed education to be an important predictor of attrition on the Selected Reserve. As in the regular Navy, non-high-school graduates are much more likely to leave within a short period of time.

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1. This probably underestimates the benefit to the Navy since the other 1.4 (or 4 less 2.6) sailors are in the reserves for some period, although less than one year.

Areas that would be fruitful for further analysis would be to examine the effect of assignment characteristics and the effects of the civilian economy. Assignment issues could be critically important since they affect readiness not only through retention but also through the quality of the match of billet requirements and individual skills. The effects of civilian earnings and unemployment might also be very important and warrant further investigation.

A final area of investigation would be to see if the decisions to affiliate and then to stay or leave are related. For example, individuals unlikely to join may also be unlikely to stay if they do join. This possibility might change the cumulative effect of the pay effects shown in table 5, since the bonus will tend to bring in more people that are unlikely to remain in SELRES, thereby diminishing the effect of the bonus on retention. Further investigation of this research topic should be a high priority.

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[5] C.R. Rao. *Linear Statistical Inference and Its Applications*, 2nd Ed. New York: John Wiley and Sons, 1973

1. The numbers in parentheses are CNA internal control numbers.