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RESEARCH MEMORANDUM

NEW ESTIMATES OF THE EFFECT OF UNEMPLOYMENT ON ENLISTED RETENTION

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A Division of CNA Hudson Institute

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ABSTRACT

This paper provides new estimates of the effect of unemployment on enlisted retention. Unemployment is found to have a positive effect upon the reenlistment rate for seven of the nine rating groups studied, and a positive effect upon both the extension rate and the total retention rate for all nine rating groups. However, the pay elasticities are three to five times as large as the unemployment elasticities, so that decreases in the unemployment rate may be offset by much smaller percentage increases in military pay.

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INTRODUCTION

An earlier CNA study [1] estimated the effects of relative military pay, reenlistment bonuses, and the unemployment rate on reenlistment and extension rates. However, that study used data from FY 1974 to FY 1980, a period during which there was relatively little variation in the unemployment rate. Wider swings in the unemployment rate since FY 1980 make estimates of unemployment effects on retention more critical for policy purposes, and they also provide the statistical variation necessary to produce these estimates.

Despite the wider swings in the umemployment rate during recent years, relative military pay has played at least as important a role as the unemployment rate in determining retention rates. Table 1 presents relative military pay, the unemployment rate of males 20 years and older, and selected first-term (length of service 3-6) retention statistics for the period FY 1977 - FY 1984. Relative military pay is defined as the ratio of the RMC index to the index of average gross hourly earnings in manufacturing. Both indices are normalized to equal 1.0 in FY 1977. Increases in the index from one year to the next indicate that RMC increased by a greater percentage than earnings in manufacturing, while decreases in the index indicate the opposite situation. The extension rate is defined as the percent of individuals who sign new contracts for less than 36 months of additional service among the pool of individuals whose enlistment contracts expire during the fiscal year. The reenlistment rate is defined as the percent of individuals who sign new contracts for at least 36 months of additional service from the same pool of individuals. The total retention rate is the sum of the extension rate and the reenlistment rate.

As table 1 indicates, relative military pay decreased from FY 1977 to FY 1979 and then increased for the remainder of the period, although the increase from FY 1982 to FY 1984 was negligible. Both the reenlistment rate and the total retention rate followed exactly the same pattern, except that the total retention rate dropped slightly in FY 1984 due to a decline in extensions. The unemployment rate again shows the same pattern, except that the drop in unemployment in FY 1984 may explain the decline in extensions that could not be explained by the essentially constant value of relative military pay.

It appears from the time-series comparisons that either relative military pay or the unemployment rate alone can explain trends in retention, and that the separate effects of these two variables may be impossible to disentangle. However, because of rating-specific Selected Reenlistment Bonuses (SRBs), military pay varies not only across years but also across ratings in a given year. This additional cross-section variation in military pay allows estimation of separate pay and unemployment effects. Moreover, military pay can explain a portion of the cross-section variation in retention rates as well as the

TABLE 1

UNEMPLOYMENT RATE, RELATIVE MILITARY PAY, AND RETENTION RATES

Fiscal year	Relative military pay[a]	Unemployment rate[b]	First-term[c] extension rate	First-term reenlistment rate	First-term total retention rate
1977	1.000	5.4	7.9	19.6	27.5
1978	.988	4.5	8.7	17.4	26.1
1979	.962	4.2	10.5	14.4	24.9
1980	.964	5.5	11.6	15.1	26.7
1981	.993	6.2	14.5	18.4	32.9
1982	1.035	8.2	17.3	22.4	39.7
1983	1.036	9.4	20.1	27.1	47.2
1984	1.038	7.0	17.1	27.5	44.6

a. Ratio of RMC index to index of average gross hourly earnings in manufacturing. Both indices are normalized to equal 1.0 in 1977.

b. Unemployment rate of males, 20 years and older.

c. Length of service cells 3-6.

time-series variation. By contrast, the unemployment rate, which varies over time but not across ratings, has no cross-section explanatory power. Therefore, military pay contributes more to the overall explanation of retention rates than does the unemployment rate. Hence, while this study reports statistically significant effects of unemployment on retention, unemployment is of only secondary importance when compared to military pay.

LOGIT MODEL

This study uses the logit model to estimate the probabilities of extending, reenlisting, and leaving the Navy. The logit model is discussed in great detail in an earlier CNA study [1] and in the statistical literature [2,3,4]. Only its most important properties will be presented here.

The logit model may be expressed in log-odds form as:

$$\log \quad (P_E/P_L) = \alpha_1 X + \beta(M_E - M_L) + u_1 \qquad (1)$$

$$\log \quad (P_R/P_L) = \alpha_2 X + \beta(M_R - M_L) + u_2 \, . \qquad (2)$$

In equations 1 and 2, P_E represents the extension rate, P_R represents the reenlistment rate, and P_L represents the separation rate. The vector X contains personal characteristics that influence the three rates, subject to the constraint that $P_E + P_R + P_L = 1$. The vector X may also contain factors such as the unemployment rate that vary over time but not in the cross-section. The pay variables M_E, M_R, and M_L represent the discounted earnings streams from extending, reenlisting, and leaving, respectively. Finally, α_1, α_2, and β are unknown coefficients, while u_1 and u_2 are random disturbances.

When using grouped data, the log-odds on the left-hand sides of equations 1 and 2 are both finite as long as P_E, P_R, and P_L are each strictly positive and strictly less than unity. The model may be estimated by generalized least squares, using the weights suggested by Cox [4] to restore equality of variances across observations.

Finally, the coefficients α_1 and α_2 do not give the partial derivatives of P_E and P_R with respect to X. Rather, the partial derivatives are given by the following formulae:

$$\partial P_E/\partial X = \alpha_1 \, P_E(1 - P_E) - \alpha_2 \, P_E \, P_R \qquad (3)$$

$$\partial P_R/\partial X = \alpha_2 \, P_R(1 - P_R) - \alpha_1 \, P_E \, P_R \, . \qquad (4)$$

Note that the signs as well as the magnitudes of the partial derivatives may differ from those of α_1 and α_2.

DATA

Data were collected on first-term (length of service 3-6) reenlistment decisions during the period FY 1977 - FY 1984. All individuals whose initial enlistment contracts expired during the period were grouped into cells defined by rating, length-of-service, and fiscal year. There were 72 ratings analyzed, 4 length-of-service cells (3-6), and 8 fiscal years. The 72 ratings were divided into the 9 rating groups listed in table 2. These are the same rating groups that were used in the earlier CNA study [1].

The extension and reenlistment rates in each cell were computed from the Defense Manpower Data Center enlisted transition tapes. The percent white, average education, and average paygrade in each cell were computed from the enlisted master tapes. The earnings streams M_E, M_R, and M_L were computed over a 4-year time horizon using a 10 percent discount rate. The earnings stream from extending, M_E, was computed as a 4-year stream of Regular Military Compensation (RMC), where RMC was predicted for each cell on the basis of length-of-service and current average paygrade. The earnings stream from reenlisting, M_R, was computed as M_E plus the SRB award. Finally, the earnings stream from leaving, M_L, was predicted from an earnings function for veterans [5], using length of service, percent white, and average education in each cell to form the prediction.

ESTIMATES

Table 3 presents the generalized least-squares estimates of the unemployment coefficients in equations 1 and 2. Note that dummy variables for length-of-service 4, 5, and 6 were included in the vector X, but the coefficients are not reported. In addition, the percent white, average education, and average pay grade were not directly included in the model, but were indirectly included through their determination of the earnings streams M_E, M_R, and M_L.

All of the logit coefficients in table 3 are positive and statistically significant. However, as was pointed out earlier, the logit coefficients do not give the partial derivatives of the retention rates. Instead, the partial derivatives were calculated using equations 3 and 4, and are displayed in table 4. Also displayed in table 4 are the unemployment elasticities, defined as the percent (not percentage point) effect on the retention rates of a 1 percent (not percentage point) increase in the unemployment rate. Note that partial derivative of the overall retention rate equals the sum of the partial derivatives of the extension and reenlistment rates. However, the elasticity of the overall retention rate equals a weighted average of the elasticities of the extension and reenlistment rates.

TABLE 2

NAVY ENLISTED RATING GROUPS

Rating group	Ratings	
Non-Electronics	BT:	Boiler Technician
	EM:	Electrician's Mate
	EN:	Engineman
	GMG, GMM, GMT:	Gunner's Mate
	HT:	Hull Technician
	IC:	Interior Communications Electrician
	IM:	Instrumentman
	MM:	Machinist Mate
	MN:	Mineman
	MR:	Machinery Repairman
	OT:	Opticalman
	PM:	Patternmaker
	TM:	Torpedoman
Electronics	AE:	Aviation Electrician
	AT:	Aviation Electronics Technician
	AW:	Aviation Anti-submarine Warfare Operator
	AX:	Aviation Electronic Warfare Technician
	DS:	Data Systems Technician
	ET:	Electronics Technician
	EW:	Electronic Warfare Technician
	FTB, FTG, FTM:	Fire Control Technician
	MT:	Missile Technician
	OT:	Ocean Systems Technician
	STG, STS:	Sonar Technician
	TD:	Training Deviceman
Aviation Maintenance	AD, ADR:	Aviation Machinist's Mate
	AME, AMH, AMS:	Aviation Structural Mechanic

TABLE 2 (CONTINUED)

Rating group	Ratings	
Ship/Aircraft Support	ABE, ABF, ABH:	Aviation Boatswain's Mate
	AO:	Aviation Ordnanceman
	ASE, ASH, ASM:	Aviation Support Equipment Technician
	BM:	Boatswain's Mate
	PR:	Parachute Rigger
Health Care	DT:	Dental Technician
	HM:	Hospital Corpsman
Logistics	AK:	Aviation Storekeeper
	DK:	Disbursing Clerk
	MS:	Mess Management Specialist
	SK:	Storekeeper
Construction	BU:	Builder
	CE:	Construction Electrician
	CM:	Constructionman
	EA:	Engineering Aide
	EO:	Equipment Operator
	SW:	Steel Worker
	UT:	Utilitiesman
Cryptology	CTA, CTI, CTM:	Cryptologic Technician
	CTO, CTR, CTT:	Cryptologic Technician
	IS:	Intelligence Specialist
Administration	JO:	Journalist
	LI:	Lithographer
	LN:	Legalman
	MU:	Musician
	NC:	Navy Counselor
	PC:	Postal Clerk
	PN:	Personnelman
	YN:	Yeoman

TABLE 3

LOGIT UNEMPLOYMENT COEFFICIENTS

Rating group	Number of cells	Extension equation		Reenlistment Equation	
		Coefficient	T-statistic	Coefficient	T-statistic
Non-Electronics	476	.094	3.71	.138	4.97
Electronics	449	.235	6.42	.174	5.58
Aviation Maintenance	128	.226	10.30	.159	6.26
Ship/Aircraft Support	281	.217	8.11	.043	1.63
Health Care	63	.377	5.77	.190	4.17
Logistics	112	.162	6.98	.099	4.24
Construction	223	.309	6.83	.065	1.49
Cryptology	203	.209	3.54	.247	5.12
Administration	214	.303	7.78	.125	2.51

TABLE 4

EFFECTS OF INCREASE IN
UNEMPLOYMENT RATE

Rating group	Extension rate		Reenlistment rate		Total Retention rate		
	Partial[a]	Elasticity[b]	Partial	Elasticity	Partial	Elasticity	Pay elasticity[c]
Non-Electronics	0.56	.318	2.27	.594	2.83	.508	1.87
Electronics	2.79	.974	2.05	.589	4.84	.763	1.95
Aviation Maintenance	2.76	.901	1.38	.480	4.64	.666	2.63
Ship/Aircraft Support	3.04	1.047	-0.15	-.040	2.89	.436	2.00
Health Care	4.47	1.705	1.90	.539	6.37	1.034	1.32
Logistics	2.02	.639	1.09	.232	3.11	.396	1.81
Construction	4.99	1.442	-0.27	-.089	4.72	.734	3.22
Cryptology	1.93	.545	3.81	.789	5.74	.686	1.86
Administration	4.37	1.302	0.75	.188	5.12	.696	2.05

a. Percentage point effect of a 1 percentage point increase in the unemployment rate.
b. Percent effect of a 1 percent increase in the unemployment rate.
c. Elasticity of the total retention rate with respect to RMC.

The partial derivatives and elasticities of the extension rate with respect to the unemployment rate are all positive. The same is true of the reenlistment rate, except for the anomalous negative signs in the Ship/Aircraft Support and Construction rating groups. However, even in the presence of these two negative signs, the partial derivatives and elasticities of the overall retention rate are all positive.

For seven of the nine rating groups, the unemployment rate has a larger effect on the extension rate than on the reenlistment rate. Hence, it appears that the retention effect of higher unemployment is distributed disproportionately toward increases in the number of extensions.

For comparison purposes, the final column of table 4 presents the elasticity of the total retention rate with respect to RMC[1]. Except for the Health Care rating group, the pay elasticities are about three to five times as large as the unemployment elasticities. It follows that a 10 percent decrease in the unemployment rate may be offset by a 2 to 4 percent increase in military pay. As another example, the 26 percent decrease in the unemployment rate from FY 1983 to FY 1984 could have been offset by a military pay increase of at most 9 percent.

Finally, the large increases in the unemployment rate and especially in military pay in FY 1981 were positively correlated with a concurrent large increase in sea pay. Because sea pay is omitted from the retention model, the pay and unemployment elasticities may both be slightly upward biased. However, the ratio of elasticties will be unbiased if both individual elasticities are biased by the same percentage.

CONCLUSIONS

This study has presented estimates of the effects of the unemployment rate on first-term reenlistment and extension rates. The effects are almost all positive, although the unemployment rate has a larger effect on the extension rate than on the reenlistment rate.

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1. The partial derivative of the total retention rate with respect to RMC equals $_{\beta}P_L(1 - P_L)$, where $_{\beta}$ is the pay coefficient. The elasticity is obtained after multiplying the partial derivative by $RMC/(1 - P_L)$, yielding the result $_{\beta}P_L RMC$. Both P_L and RMC are evaluated at the sample means.

While unemployment is an important determinant of retention, it is of only secondary importance when compared to military pay. Military pay can be used not only to offset changes in unemployment from year to year, but also to control differences in retention rates across ratings through reenlistment bonuses. Flexible, targeted pays such as reenlistment bonuses are the Navy's most potent tool for controlling retention rates.

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