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NAVY PERSONNEL RESEARCH
AND
DEVELOPMENT CENTER
San Diego, California 92152

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AN ECONOMETRIC MODEL OF NAVY ENLISTMENT BEHAVIOR

Barry S. Siegel
Jules Borack

Reviewed by
Joe Silverman

Released by
James F. Kelly, Jr.
Commanding Officer

Navy Personnel Research and Development Center
San Diego, California 92152

FOREWORD

This effort supports exploratory development under Task Area ZF63-521-001-010, Manpower Management Decision Technology, Work Unit 3.16, Accession Planning Models. The objective of this effort is to identify and measure those variables and interrelationships that define the national/regional supply of enlisted personnel for the Navy. This report describes an econometric model of the enlistment process, provides parameter estimates of the model, and forecasts "supply" (or, more accurately, enlistment contracts) under alternative scenarios. The results are intended for use by Navy personnel planners.

James F. Kelly, Jr.
Commanding Officer

James J. Reagan
Techincial Director

SUMMARY

Problem and Background

The size of the prime enlistable population (males 17-21 years old) will decline in the 1980s. In addition, the demand for entry-level youth should increase due to current plans to enlarge the size of the military services. As a result, it is important to analyze and understand the factors underlying the decision to enlist and forecast nonprior service enlistments based upon those factors. While a number of research efforts have investigated the variables associated with enlistment supply, few models have incorporated variables relating to enlistment requirements. There are reasons to believe that the number of high quality (e.g., high school diploma graduate) enlistees is related to enlistment requirements. These reasons relate to the relationship between recruiter effort and recruiting requirements. Therefore, models that ignore the effects of requirements will be misspecified.

Objective

The objective of this effort was to develop an econometric model of Navy nonprior service male enlistees. This model is called the Enlistment Personnel Supply Model (EPSUM).

Approach

EPSUM was developed to estimate the effects of certain variables on the number of high school diploma graduate enlistment contracts. These variables include the number of recruiters per capita, the recruiting goal per capita, the unemployment rate, employment expectations, interest in joining the Navy, and the ratio of civilian to military wages. Using a log-interaction functional form, the model was estimated via Zellner's (1962) Seemingly Unrelated Regression technique with Navy Recruiting District data for fiscal years 1977, 1978, and 1979. F-Statistics were formed to test for the stability of the parameters over time.

Results

A number of variables were found to significantly influence enlistment behavior. Based on the parameter estimates, enlistment supply elasticities were derived. For example, the recruiter elasticities ranged from .97 in 1977 to .70 in 1979, while the civilian/military pay elasticities ranged from -.43 in 1977 to -.26 in 1979. The model was cross-validated and the forecasts were reasonably accurate. Supply projections were provided for the period 1981-1986 based on the latest Five Year Defense Plan (FYDP) and a 72 percent high school diploma graduate quota. No shortfalls are projected.

Conclusions

Econometric models such as EPSUM provide policy-makers with techniques to forecast enlistments to the Navy under alternative scenarios. Further extensions of the model and its uses should be investigated, including the incorporation of advertising and other service competition variables.

Recommendations

Forecasts from EPSUM should continue to be used in the Navy's Structured Accession Planning System (STRAP) to estimate the supply constraint employed in enlisted manpower programming. The model should also be considered for use by Navy planners in other applications requiring accurate forecasts of future Navy enlistments.

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INTRODUCTION

Problem and Background

The size of the prime enlistable population (males 17-21 years old) will decline in the 1980s due to the fall in fertility rates following the post World War II baby boom. In addition, the demand for entry-level youth should increase due to current plans to enlarge the size of the military services. As a result, it is important to analyze and understand the factors underlying the decision to enlist and forecast nonprior service enlistments based upon those factors.[1]

In recent years, a number of studies have estimated the magnitudes of various factors that are hypothesized to influence Navy enlistment behavior. With few exceptions, these studies utilized single equation regression techniques to relate the high quality enlistment rate (quality-specific enlistments divided by the relevant population (e.g., 17-21 year old males) to the number of recruiters, the ratio of civilian to military wages, advertising expenditures, and the unemployment rate. These efforts to investigate the variables associated with enlistment supply have been hampered by enlistment data of relatively poor quality and by the general lack of information on the socioeconomic characteristics of enlistment behavior. While the influence of certain variables (e.g., unemployment rate) is generally consistent in most models of enlistment behavior, the influence of other variables (e.g., advertising expenditures) is not. These inconsistent findings are, in part, due to the different functional forms and supporting data underlying the models. Another possible cause, however, is the failure of these models to consider the effect of requirements (goals) on the quality distribution of enlistees.

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[1]We distinguish the term "enlistments" from "accessions" and "contracts." The term enlistments is used in a general sense to denote either accessions to active duty or service contracts. The latter terms are clearly more restrictive. Conceptually, all three terms are surrogates for supply.

Indeed, although these efforts have contributed to our understanding of recruitment supply, they have implicitly modeled enlistments, not supply. This follows since many individuals who might enlist do not do so because they are not actively recruited. Goldberg (1979), for example, found that recruiting goals affect the number of high quality recruits. This implies that supply is something more than actual enlistments.

Objective

The objective of this effort is to develop an econometric model of Navy nonprior service, male enlistments. This model addresses the issues discussed above and can be used to provide forecasts of enlistments in the 1980's. For ease of identification, we call the model EPSUM (Enlisted Personnel Supply Model).

EPSUM differs from previous efforts in a number of respects. First, cross-section enlistment data are examined for three fiscal years: 1977, 1978, and 1979. Enlistment requirements and economic conditions varied considerably during this period. Second, variables measuring quality requirements (i.e., quotas) are explicitly included in the estimating equation. Third, the effects of previously unexplored variables (e.g., employment expectation, enlistment interest) on enlistment behavior are investigated. The next section explores the relationship between goals and quotas in the context of econometric models.

ECONOMETRIC MODELS AND THE SUPPLY OF ENLISTMENTS

Recruiting Goals and Quality Quotas

Labor economics conventionally assumes that the supply of and demand for labor services are balanced through adjustments in market wages. In the military sector, however, both the demand for labor services (recruiting goals) and the wage rate are fixed by Congress. As a result, given both a specific requirement to enlist a number of individuals and a fixed level of recruiting resources, the Navy attempts to "maximize" the quality of its recruits.

At the national level, the Navy specifies enlistment goals and quality quotas. Enlistment goals, the numerical requirements for recruits, are derived from Congressionally-mandated force levels and vacancies created by internal attrition. Quality quotas are specific targets expressed as percentages of total recruitment goals that are to be of a particular quality level. In FY78, for example, the Navy established a 76 percent high school diploma graduate (HSDG) quality quota. At that time, the goal for nonprior service male enlistees was 79,089. Thus, at the national level, 60,107 HSDG (high quality goal) and 18,982 non-HSDGs (low quality goal) were required. Since relatively few non-HSDGs were required, a supply "problem" exists only for high quality (i.e., HSDG) enlistees.

While goals and quotas are specified at the national level, the actual recruitment of individuals occurs at the local level. The Navy Recruiting Command (NRC) allocates a fraction of the national goal to each of the six Navy Recruiting Areas (NRAs) within the United States. The NRA Commanders, in turn, suballocate their goal to each Navy Recruiting District (NRD) within the area. There are some 43 NRDs within the United States. Historical enlistment rates and regional population differentials are the primary determinants of these allocations, although economic and demographic conditions are also considered. While the national quality quotas are not strictly binding at the NRA and NRD levels, administrators are cognizant of the fact that their productivity is measured not only by the total number but also the quality of enlistees.

The Relationship of Goals, Recruiting Effort, and Enlistments

Previous enlistment supply models have assumed that, for a fixed level of recruiting resources, recruiters enlist as many high quality individuals as possible. If this assumption is correct, the recruiting goal should not influence the number of high quality enlistees. There are reasons to believe, however, that the number of quality enlistees is influenced by the recruiting goal. One set of reasons is related to the hypothesis that recruiter effort is correlated with the size of the goal, while another set is related to the process by which recruiting goals are allocated.

The hypothesis that recruiter effort is correlated with the size of the goal derives from the rewards and penalties associated with over and undersubscribing the goals. It is important to note that the goals promulgated relate to accessions ("shipment" of individuals to bootcamp), not to enlistment contracts. Since there are limits to the capacity of bootcamps, recruiters are not encouraged to exceed their recruiting goals. Thus, once the high and low quality goals are attained, recruiters may have little incentive to maintain their previous level of effort. This argument suggests that the number of high quality enlistees may be limited by goals, particularly in those NRAs and NRDs that attain their goals.

It should be noted, however, that once the quality goal has been attained, recruiters can write Delayed Entry Program (DEP) enlistment contracts for accessions in the next year. By enrolling in the DEP, the recruit is placed in the Individual Ready Reserve (IRR) until reporting to bootcamp. The recruit receives credit toward his 6-year obligation (active and reserve) for the time spent in the DEP. Depending upon the enlistment contract terms, recruits may remain in the DEP for as long as 12 months. In this way, the DEP acts as both an enlistment incentive and a managerial device for scheduling accessions. Based on the above considerations, the appropriate measure of current recruiting productivity is enlistment contracts, not accessions. Nevertheless, because recruiters are limited in the number of DEP contracts they can offer, there may still be a relationship between the quality goal, recruiter effort, and the number of quality (e.g., HSDG) contracts.

The above discussion suggests that enlistment supply models should include a quality goal variable to proxy recruiter effort. However, since the distribution of goals among NRDs and NRAs is a function of historical enlistment rates and population, the goals themselves are a function of all of the variables that entered into the determination of past enlistments. Thus, if a quality goal variable is not included in the estimating equation, the parameter estimates of most variables would tend to obscure the true relationship between these variables and enlistments. This follows because the variables also influenced enlistments indirectly through their past effect on the distribution of enlistees. In any event, the introduction of the goal variable into the estimating equation will, to some extent, affect the parameter estimates of all of the other variables in the model.

To formalize this argument, let E^t be the number of high quality enlistees in period t, X^t be a supply factor (e.g., unemployment rate) in period t, and G^t be the quality goal in period t. Without loss of generality, assume a linear relationship between enlistments, the supply factor, and the quality goal:

$$E^t = B_0 + B_1 X^t + B_2 G^t + e^t \tag{1}$$

where B_0, B_1, and B_2 are the regression coefficients and e^t is the stochastic error term in period t.

Assume a distributed-lag relationship to express the goal in periods t and t-1:

$$G^t = b_0 + b_1 X^{t-1} + b_1 \lambda X^{t-2} + b_1 \lambda^2 X^{t-3} + \ldots + \gamma E^{t-1} \tag{2}$$

and

$$G^{t-1} = b_0 + b_1 X^{t-2} + b_1 \lambda X^{t-3} + b_1 \lambda^2 X^{t-4} + \ldots + \gamma E^{t-2} \tag{3}$$

where λ is a constant $0 < \lambda < 1$. Equations (2) and (3) state that the goal in any given period is a function of enlistments in the previous period and discounted supply factors defined for previous periods. Note that:

$$G^t - \lambda G^{t-1} = b_0 - \lambda b_0 + b_1 X^{t-1} + \gamma E^{t-1} - \gamma\lambda E^{t-2} \tag{4}$$

Thus,

$$G^t = (1-\lambda) b_0 + b_1 X^{t-1} + \gamma E^{t-1} - \gamma\lambda E^{t-2} + \lambda G^{t-1} \tag{5}$$

Substitution of equation (5) into equation (1) yields:

$$E^t = B' + B_1 X^t + b_1 B_2 X^{t-1} + B_2 \gamma E^{t-1} - B_2 \gamma\lambda E^{t-2} + B_2 \lambda G^{t-1} + e^t \quad (6)$$

where

$$B' = B_0 + B_2 b_0 (1-\lambda)$$

The same procedure could be employed to derive G^{t-1} as a function of G^{t-2}. For simplicity, assume that enlistments began one period ago ($E^{t-2} = 0$), and that the relationship between X^t and X^{t-1} is a simple linear trend:

$$X^{t-1} = \delta X^t \quad (7)$$

where $\delta > 0$

Substituting equation (7) into equation (6) yields equation (8):

$$E^t = B' + (B_1 + B_2 b_1 \delta) X^t + B_2 \gamma E^{t-1} + B_2 \lambda G^{t-1} + e^t \quad (8)$$

Unless substantial structural change has occurred, the relationship between X^{t-1} and E^{t-1} will be the same as that between X^t and E^t. Thus, if equation (1) is estimated, the true effects of the various explanatory variables will be understated, since $|B_1 + B_2 b_1 \delta| \geq |B_1|$. However, if equation (8) is estimated, it is not statistically possible to uniquely identify the individual parameters of the model. In addition, numerous econometric problems are introduced when a lagged dependent variable (E^{t-1}) is included as an explanatory variable. Therefore, a form of equation (1) is estimated, with the proviso that the parameter estimates of the explanatory variables will be understated and the parameter estimate of the goal variable will be overstated. The magnitude of parameter bias, however, will be unknown.

In summary, enlistments from a given quality category may be viewed as a result of the interplay between supply and demand and not simply a description of supply. Assuming that wages, bonuses, benefits, etc. are fixed, the Navy can effectively choose only two of three policy variables (goals, quality quotas, and recruiting resources); the market determines the third. Thus, the Navy can specify the recruiting budget, determine the recruiting goal, and accept the resulting quality distribution. Conversely, with a given recruiting budget, the Navy can establish a binding quality quota and recruit as many total individuals as possible subject to this constraint.

The next section discusses the formulation of an econometric model that takes the complex relationship of goals, quotas, and recruiting effort into account.

MODEL STRUCTURE

Formulation

The spatial unit employed in this model is the NRD, of which there are 43. Complete sets of observations from each NRD were available for fiscal years 1977, 1978, and 1979. Thus, 129 (43 x 3) observations form the data base. Following Jehn and Shughart (1976), the log-interaction functional form is estimated:

$$
\begin{aligned}
E_i^t/POP_i^t = \; & a_0 + a_1 \ln(REC_i^t/POP_i^t) + a_2 \ln(G_i^t/POP_i^t) \\
& + a_3 \ln(REC_i^t/POP_i^t) \ln(G_i^t/POP_i^t) \\
& + a_4 \ln(REC_i^t/POP_i^t) \ln(G_i^t/POP_i^t)\, UNR_i^t \\
& + a_5 \ln(REC_i^t/POP_i^t) \ln(G_i^t/POP_i^t)\, EMP_i^t \\
& + a_6 \ln(REC_i^t/POP_i^t) \ln(G_i^t/POP_i^t)\, INT_i^t \\
& + a_7 \ln(REC_i^t/POP_i^t) \ln(G_i^t/POP_i^t)\, PAY_i^t \\
& + \text{error}
\end{aligned}
\qquad (9)
$$

where:

E_i^t = Nonprior service male HSDG contracts for active duty in NRD i in year t; Source: NRC.

POP_i^t = Graduates from high school in NRD i in year t; Source: Defense Manpower Data Center (DMDC).

REC_i^t = Factored canvassers (recruiters) in NRD i in year t; Source: NRC.

G_i^t = HSDG accession goal for active duty males in NRD i in year t; Source: Program Analysis Documents, NRC.

UNR_i^t = Total labor force unemployment rate for the largest Standard Metropolitan Statistical Area (SMSA) within NRD i in year t; Source: Bureau of Labor Statistics.

EMP_i^t = Percentage of Youth Attitude Tracking Survey (YATS) respondents who answered "not difficult" when asked about employment availability in NRD i in year t. Source: DMDC, Recruit Marketing Network.

INT_i^t = Percentage of all Armed Services Vocational Aptitude Battery (ASVAB) examinees who planned a military career in NRD i in year t; Source: DMDC, Recruit Marketing Network.

PAY_i^t = Ratio of average civilian earning in largest SMSA to average first year basic pay, in NRD i in year t; Source: Bureau of Labor Statistics, Military Pay Tables.

This functional form was chosen because the impact that the unemployment rate, employment perceptions, interest, and pay have on enlistment is related to both the number of recruiters and to the recruitment goal. Additionally, the number of recruiters and the recruitment goal are themselves viewed as key variables.

In this regard, most previous supply analyses have found that the number of recruiters were the most important variable associated with enlistments. This finding is not surprising since the number of recruiters is a proxy for both recruiting effort and the availability of information regarding Navy opportunities.

There are numerous ways of defining a recruiter variable. Total recruiting personnel consist of production canvassers, support personnel, and administrators. Production canvassers are field personnel who are most directly charged with attainment of specific goals. In addition, since a recruiter's productivity may increase with experience, production canvassers may be weighted by an experience (or "time on board") factor; hence the term "factored" canvassers. These time-on-board weights, derived by the Navy Recruiting Command, are:

Time-on-Board	Factor
Less than 1 Month	.28
1-3 Months	.70
3-6 Months	.90
Over 6 Months	1.00

While various definitions have been used in econometric supply models, the factored canvasser definition has been chosen for the present work, since it includes experience as part of the measure.

The goal variable is a surrogate for overall recruiting effort. This variable is defined as the total requirement for nonprior service active duty males (in a particular NRD) multiplied by the national quality quota for high school diploma graduates. This is equivalent to the desired number of high school diploma graduates. These quality quotas were 71.5 percent for 1977, 76 percent for 1978, and 76 percent for 1979.[2] Note that, for a single year of cross-section data, the quality quota adjustment to the aggregate goal will not affect the signs and significance levels of the coefficients derived from regression analyses, since the adjustment is equivalent across all NRDs.

It is hypothesized that the high school diploma graduate contract enlistment rate is positively related to the number of recruiters per high school graduate ($a_1 > 0$), the goals per high school graduate ($a_2 > 0$), the unemployment rate ($a_4 > 0$), and interest ($a_6 > 0$); and

---

[2]In FY77, no HSDG quality quota was explicitly stated. The 71.5 percent quota reflects actual percentage attainment.

negatively related to employment expectations ($a_5 < 0$) and the ratio of civilian to military pay ($a_7 < 0$). As discussed below, the interaction term between recruiters per high school graduate and goals per high school graduate (a_3) is hypothesized to be positive.

<u>Marginal Products and Elasticities of Variables</u>

Once parameters have been estimated for this model, marginal products and elasticities can be calculated for each variable. A marginal product is defined as the change in enlistments that results from a unitary change in an explanatory variable, holding the effects of the remaining explanatory variables constant. An elasticity is defined as the percentage change in enlistments that results from a one percent change in an explanatory variable.

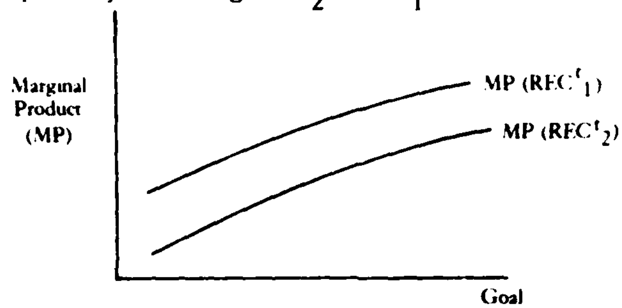
The marginal productivities of goals and recruiters are given by equations (10) and (11) respectively:

$$\partial E_i^t / \partial G_i^t = a_2 (POP_i^t/G_i^t) + a_3 \ln (REC_i^t/POP_i^t)\, POP_i^t/G_i^t + \sum_{k=4}^{7} a_k \ln(REC_i^t/POP_i^t)\,(POP_i^t/G_i^t)\, X_k \qquad (10)$$

$$\frac{\partial E_i^t}{\partial REC_i^t} = a_1 (POP_i^t/REC_i^t) + a_3 \ln (G_i^t/POP_i^t)\, POP_i^t/REC_i^t + \sum_{k=4}^{7} a_k \ln (G_i^t/POP_i^t)\,(POP_i^t/REC_i^t)\, X_k \qquad (11)$$

where X_k is the independent variable associated with coefficient a_k. By multiplying both sides of equations (10) and (11) by (G_i^t/E_i^t) and (REC_i^t/E_i^t) respectively, one obtains the corresponding elasticities.

Like many economic resources, the marginal productivity of recruiters is likely to exhibit diminishing returns. Ceteris paribus, additional recruiters will induce fewer and fewer enlistees as the enlistable population per recruiter declines. Eventually the entire recruitable population is being actively pursued, in which case the marginal productivity should fall to zero. This suggests that the marginal productivity of recruiters should be positive but diminishing. In addition, productivity should be an increasing function of the recruiting goal. Graphically assuming $REC_2^t > REC_1^t$:



If $a_1 > 0$ and $a_3 > 0$, equation (11) will exhibit these desired properties.

It is important to note that the recruiter (goal) marginal product and elasticity are calculated holding the effect of goal (recruiter) constant. If our hypothesis about goal and recruiter effort is correct, an increase in recruiters without a corresponding increase in goal should elicit few additional enlistees. Thus, it makes little sense to examine the effects of an additional recruiter without a corresponding analysis of the effects of an increase in goal that accompanies this addition. In mathematical terms, enlistments (E) is a function of recruiters (R) and the goal (G):

$$E = E(R,G) \tag{12}$$

The total differential is:

$$dE = \frac{\partial E}{\partial R} dR + \frac{\partial E}{\partial G} dG \tag{13}$$

Dividing both sides of equation (13) by dR, equation (14) is obtained:

$$\frac{dE}{dR} = \frac{\partial E}{\partial R} + \frac{\partial E}{\partial G}\frac{dG}{dR}. \tag{14}$$

Equation (14) states that the effect of an additional recruiter consists of a direct effect and an indirect effect. The direct effect, $\partial E/\partial R$, represents the marginal product of an extra recruiter and is calculated using equation (11). The indirect effect, $(\partial E/\partial G)$ (dG/dR), is the marginal product of the goal (calculated using equation (10)) multiplied by the change in the goal induced by the addition of a recruiter.

The marginal products of the remaining explanatory variables are given by:

$$\frac{\partial E_i^t}{\partial X_k} = a_k POP_i^t \ln (REC_i^t/POP_i^t) \ln (G_i^t/POP_i^t) \qquad (15)$$

where X_k is the independent variable associated with coefficient a_k $(k = 4, \ldots 7)$. The corresponding elasticities are found by multiplying each side of (15) by X_k/E_i^t. Note that these elasticities have the desirable properties of being directly related to the number of recruiters and/or the size of the recruiting goal. For example, the effect of a change in the unemployment rate will be greater, ceteris paribus, the larger the size of the goal, and the greater the recruiting effort.

MODEL ESTIMATION

Estimation Technique

In order to make inferences about the impact of time upon the parameters of the model, separate cross-sectional regressions were estimated for each fiscal year. Because of both the goaling process and the likelihood that unquantifiable recruiting policies varied from year to year, the cross-year residuals are likely to be correlated. Under these circumstances, the appropriate technique is Seemingly Unrelated Regressions (Zellner, 1962), which improves the statistical efficiency of the coefficient estimates.

Estimates of Parameters and Elasticities

Equation 1.1 in Table 1 contains the parameter estimates and t-ratios associated with relationship (9) for FY 1977, equation 1.2 for FY 1978, and equation 1.3 for FY 1979. With the exception of the coefficient on EMP_i^t for 1979, all of the coefficients reported in Table 1 have the expected sign, and most are statistically significant at the 5 percent level or better.[3] The percentage of explained variance is of reasonable magnitude in each relationship, ranging from a low of .67 in Equation 1.1 to a high of .82 in Equation 1.3.

Table 1

HSDG Contracts: Regression
Coefficients (b) and T-Ratios (t)

Item		1977 (1.1)	1978 (1.2)	1979 (1.3)
Recruiters	b	0.14302*	0.10244*	0.04980*
	t	(2.276)	(3.316)	(2.090)
Goals	b	0.38343*	0.23162*	0.12293*
	t	(2.966)	(3.813)	(2.575)
Interaction	b	0.05084*	0.03098*	0.01384*
	t	(2.497)	(3.261)	(1.863)
UNR	b	0.00006*	0.00004	0.00002
	t	(1.910)	(1.561)	(0.910)
EMP	b	-0.00166	-0.00000	0.00040
	t	(1.525)	(0.017)	(1.117)
INT	b	0.00049	0.00221*	0.00194*
	t	(0.0269)	(1.957)	(2.254)
PAY	b	-0.00018*	-0.00008*	-0.00006*
	t	(2.661)	(1.964)	(2.055)
Constant	b	1.15980*	0.80454*	0.47023*
	t	(2.922)	(4.181)	(3.149)
$\bar{R}^2$		0.6792	0.7464	0.8296
SSR		0.0018788	0.0010443	0.00081396
SEE		0.0066100	0.0049282	0.0043508

*p < .05 ($t \geq 1.65$)

[3]As noted earlier, recruiters and recruiting goals are allocated on the basis of many of the same variables. Indeed, for each year under study, the simple correlation between the allocation of recruiters and goals was in excess of .9. These high correlations are likely to induce multicollinearity into the regression equation, which would have the statistical effect of raising the standard errors of the coefficients. Nevertheless, the coefficients associated with the recruiter per capita (a_1), goal per capita (a_2), and interaction (a_3) variables are all positive and statistically significant (at the 5% level or better).

As a test for the significance of the difference between corresponding parameter estimates for 1977 and 1978, 1978 and 1979, and 1977 and 1979, F-statistics were employed to test the hypothesis that the coefficients on a given variable are equal for any 2 years. These F-statistics appear in Table 2.

Table 2

HSDG Contracts: F-Statistics

Item	1977-1978 (1.1)	1978-1979 (1.2)	1979-1980 (1.3)
Recruiters	3.145	0.508	2.216
Goals	3.489	1.648	4.092*
Interaction	3.539	1.143	3.331
UNR	0.360	0.382	0.943
EMP	0.386	2.988	3.600
INT	0.072	1.457	0.697
PAY	0.288	3.530	3.477
Constant	3.322	0.974	3.047

*$p < .05$ ($F_{1,70} = 3.95$).

The coefficients associated with each variable are remarkably stable over the three periods. Only the coefficient associated with G_i^t/POP_i^t (a_2) declined significantly between 1977 and 1979, although the decline was not significant between 1977 and 1978, or 1978 and 1979. Note that this finding may not indicate that the total effect of the goal declined, since the coefficient associated with the interaction term (a_3) did not decrease significantly.

Given the parameters in Table 1, equation (14) can be evaluated at the means of the explanatory variables to provide estimates of the marginal productivity and elasticity of additional recruiters. The marginal product of an additional recruiter ($\partial E/\partial R$), holding the effect of the goal constant, can be estimated using equation (11). For 1979, the estimate was found to be 2.47 high school diploma graduate contracts. The average product was in excess of 21 high school diploma graduate contracts. The small marginal product vis-a-vis average product is, of course, due to the fact that the goal was held constant in the calculation. Hence, as expected, increasing the number of recruiters without a corresponding increase in the recruiting goal will induce few additional high school diploma graduate contracts.

To calculate the indirect effects of an additional recruiter due to change in the goal, the second term on the right side of equation (14) $(\frac{\partial E}{\partial G} \frac{dG}{dR})$ must be evaluated. The partial derivitive $(\partial E/\partial G)$ is the change in HSDG contracts that results from a unitary increase in the goal, and can be calculated using equation (10). For 1979, this partial derivitive is estimated to be .952. The total derivitive (dG/dR) is the change in the goal that results from a unitary increase in the number of recruiters. This derivitive is estimated on the basis of a linear regression of the HSDG goal on the independent variables in the model, including recruiters. (A complete discussion of the methodology to derive the relationship between recruiters and goals is provided in Appendix A.)

It was found that, in 1979, an additional canvasser was associated with a 12.9 HSDG goal increase. Thus, the indirect effect is:

$$(\partial E/\partial G)(dG/dR) = (.952)(12.9) = 12.3.$$

Combining direct and indirect effects (2.4 + 12.3), the total effect of an additional recruiter in 1979 is estimated to be 14.7 high school diploma graduate contracts. Evaluated at the means of the other independent variables, this result implies an elasticity of .70. Similar types of calculations can be performed for 1977 and 1978. These calculations appear in Table 3, which indicates that a substantial decline in recruiter productivity occurred between 1977 and 1979. This finding stems, at least in part, from the functional form of the model. As evident from equation (11), the productivity of recruiters is a function of the values of all of the explanatory variables in the model. Between 1977 and 1979, many of the supply variables became less favorable towards military enlistment. For example, the civilian unemployment rate declined from 6.3 percent to 5.1 percent, both employment expectations and the ratio of civilian to military pay rose, and expressed interest to join the Navy decreased. The most important factor contributing to the decline in recruiter productivity, however, may have been the 25 percent decline in the recruiting goal during this period.

Table 3

Marginal Products and Elasticities of Recruiters
With Respect to HSDG Contracts

Item	1977	1978	1979
Marginal Product	27.0	17.1	14.7
Elasticity	0.97*	0.77*	0.70*

*$p < .05$.

The marginal products and elasticities shown above are comparable to those found by Morey (1981) and higher than Goldberg's (1981). Morey, using pooled time-series cross-section data from the period 1/76 to 12/78, found a production canvasser elasticity of .72. Goldberg, however, estimates a 1979 elasticity of .48 and a corresponding marginal product of nine high school diploma graduate contracts.

Elasticities for the remaining independent variables can be calculated using equation (15). These elasticities appear in Table 4.

Table 4

Model Elasticities

Item	1977	1978	1979
Unemployment Rate	0.16*	0.13	0.08
Employment Expectation	-0.11*	0.0	0.05
Interest	0.02	0.12*	0.11*
Civilian/Military Pay	-0.43*	-0.29*	-0.26*

*$p < .05$.

To the extent that individuals are motivated to enlist by the lack of employment opportunities available in the civilian sector, the unemployment variable should exhibit a positive sign. Although the coefficients are not significant in 1978 or 1979, the signs are positive for each year. The elasticities range from .16 in 1977 to .08 in 1979. Goldberg (1981) found an unemployment rate elasticity of .43, while Morey (1981) estimated an elasticity of .18.

One possible rationale for the lack of significance of unemployment rates is the quality of the underlying unemployment data. It was necessary to utilize total labor force data rather than youth unemployment data. Another possible explanation is that the unemployment rate reflects only current unemployment and may not necessarily be indicative of prospects for future employment. Since the studied population consists principally of young males without labor market experience, the relationship between unemployment rates and aggregate measures of enlistments may be somewhat ambiguous. Therefore, an employment expectations variable is included in the estimating equation.

The employment expectations variable was defined as the percentage of YATS respondents who indicated that employment opportunities were easy to obtain. The results associated with this variable are not particularly noteworthy. Only in 1977 was the coefficient negative and statistically significant with an elasticity of -.11. Neither Goldberg (1981) nor Morey (1981) include this variable in their models.

Enlistment interest is a variable included to proxy omitted variables and regional "taste" differences. The interest variable was defined as the percentage of ASVAB examinees who indicated that they planned a military career. This variable was significant in the expected direction in 1978 and 1979 with elasticities of .12 and .11 respectively. While Goldberg (1981) did not include an interest measure in his model, Hanssens and Levien (1980) found elasticities comparable to the ones presented here. Interestingly, higher elasticities were found for military propensity in general, rather than

Navy propensity. This result was also obtained by Morey (1981), who found a military propensity elasticity of .67.

The ratio of civilian to military earnings was utilized to proxy the impact of perceived compensation upon the decision to enlist. The civilian earnings variable was defined as the average yearly earnings of production workers on manufacturing payrolls, while the military earnings variable represents average first year basic pay. The coefficient associated with this variable is, as expected, negative and significant for all 3 years. The elasticity ranges from -.43 in 1977 to -.26 in 1979. Goldberg (1981) found higher (-1.02) and Morey (1981) lower (-.16) elasticities for this variable. The differences between models may be due to different specifications of the civilian-military pay variable.

In summary, with the exception of the interest variable, the estimated elasticities declined between 1977 and 1979. During this period, total recruiting goals also declined. Hence, the results presented here lend support to the hypothesis that the magnitudes of the effects of the variables associated with high school graduate contracts are themselves a function of recruiting effort. The results also indicate that the quantitative relationships (parameters) between enlistment behavior variables and actual enlistments are relatively stable.

Appendix B contains a discussion of variables excluded from the final formulation of the model.

VALIDATION AND SUPPLY FORECASTS

Model Validation

To test the predictive accuracy of the model, parameter estimates based on 2 years of pooled data were used to predict the estimates for the third year. For example, to predict FY79 results, data from FY77 and FY78 were pooled, and the resulting parameter estimates were applied to actual FY79 data. A Chow test was performed on the pooled data to confirm the appropriateness of pooling. The results of this cross-validation appear in Table 5. It should be noted that the technique of validation may understate the accuracy of the model since only 2 years of data, rather than 3, were used in developing the predictor equation.

Table 5

Model Cross Validation

Item	1977	1978	1979
Actual HSDG Contracts	75740	60995	57725
Forecast HSDG Contracts	71850	62396	54876
Percent Error	-5.1%	+2.2%	-4.9%

Supply Forecasts 1981-1986

This section presents forecasts of nonprior service male contracts derived from the model. Prior to fiscal year 1980, quality quotas were expressed in terms of HSDGs. In FY78, for example, the Navy established a quota that required at least 82 percent of nonprior service male recruits to be high school graduates, including equivalence diploma (GED) graduates. Beginning with fiscal year 1980, the Navy required a minimum of 74 percent of new recruits to be in mental categories I-IIIA. In FY81, this requirement was further altered because of the renorming of the ASVAB exam.

The Navy Recruiting Command estimated that, in FY 1980, if 74 percent of nonprior service male recruits were in mental categories I-IIIA, 72 percent would be high school diploma graduates. In fact, in FY80, the Navy overachieved its stated quality quota: 75.6 percent of total nonprior service males accessions were in mental categories I-IIIA, and 73.1 percent were high school diploma graduates. For forecasting purposes, a 72 percent high school diploma graduate quota will be assumed.

Table 6 provides the projected nonprior service male requirements (goals) for fiscal years 1981 through 1986 based on the latest Five Year Defense Plan (FYDP) and the 72 percent HSDG quality quota. Note that the HSDG goals specified are at or below the

HSDG goal in FY79, the lowest level experienced during the period studied. Thus, in order to forecast enlistments with these relatively low goals, the parameter estimates based on the FY79 equation (the year with the lowest goal) was utilized.

Table 6

Total and HSDG Goal for Nonprior Service Navy
Male Accessions (000s)--1981-1986

Year	Total Goal	HSDG Goal (72%)
1981	80.9	58.2
1982	77.7	55.9
1983	73.9	53.2
1984	72.9	52.4
1985	71.0	51.1
1986	73.3	52.7

Forecasts are generated on the basis of three different unemployment rate scenarios. These unemployment rate scenarios appear in Table 7.

Table 7

Unemployment Rate Scenarios

		Scenario	
Year	Low	Moderate	High
1981	7.5	8.0	8.5
1982	6.9	7.7	8.3
1983	6.1	7.1	7.7
1984	4.2	6.4	7.2
1985	4.0	6.0	7.0
1986	4.0	6.0	7.0

The values of the EMP_i^t and INT_i^t variables are assumed to remain at the FY79 levels. The number of recruiters is assumed to remain at the FY81 level, which is roughly 3 percent above the FY79 level. In addition, as the result of a recent military pay increase, military pay is assumed to rise by 5 percent more than civilian pay in FY81, and to rise at the same rate as civilian pay thereafter. Additionally, the number of high school graduates is assumed to decline in proportion to the decline in the 17 to 21-year-old male population. The supply projections derived from these assumptions are found in Table 8.

Table 8

Supply Projections 1981-1986
HSDG Contracts

	Unemployment Rate Scenario		
Year	Low	Moderate	High
1981	63,244	63,652	64,060
1982	60,570	61,205	61,682
1983	57,483	58,090	58,546
1984	55,190	56,786	57,367
1985	53,853	55,210	55,963
1986	53,882	56,814	57,502

Note that the unemployment rate exerts a small but measurable effect on the number of HSDG contracts. For example, the difference between the high unemployment and low unemployment rate scenario in 1986 is 3 percentage points (7.0-4.0). This difference translates into 3620 (57502-53882) high school diploma graduate contracts. Also note that, for each year and scenario, the supply projection exceeds the HSDG goal shown in Table 6. This result is not surprising since the total and HSDG goals are substantially below the historical values experienced during FY 1977 through FY 1979.

In addition, with the exceptions of the low unemployment rate scenarios and the slight decline in the high schol graduate population, the assumptions relating to the values of compensation and recruiter variables are favorable toward increasing supply relative to 1979. Thus, no shortfalls are projected for the 1981-1986 period. Of course, this assumes no revision in the FYDP scenario--which is normally subject to change twice a year. With changes in political direction, the shift in FYDP goals may be significant.

CONCLUSIONS AND RECOMMENDATIONS

Econometric models of enlistment behavior provide policy-makers with techniques to forecast high quality enlistments to the Navy under alternative scenarios. However, due to the correlations between several of the variables (in particular, the concomitant determination of recruiter allocation, advertising expenditures, and goals), the parameter estimates of particular variables are unreliable. Hence, regression models such as the one presented here are unlikely to yield reliable estimates of the effects of policy changes that are outside the range of the historical data. However, for utility as a forecasting device, the model presented in this report has been shown to be reasonably accurate.

Forecasts from the EPSUM model have been installed in the Navy's Structured Accession Planning System (STRAP), and are being used to estimate the supply constraint employed in enlisted manpower programming. The model should also be considered for use by Navy planners in other applications requiring accurate forecasts of future Navy enlistments.

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APPENDIX A

THE RELATIONSHIP BETWEEN RECRUITERS AND GOALS

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To estimate the change in the goal that would result from an increase in the number of recruiters, the following linear equation was estimated via ordinary least squares:

$$G_i^t = b_0 + b_1 POP_i^t + b_2 REC_i^t + b_3 UNR_i^t + b_4 INT_i^t + b_5 EMP_i^t + b_6 PAY_i^t \qquad (1A)$$

The estimated parameters and corresponding t-ratios appear in Table A-1.

The estimate of dG/dR for equation (14) of the text is simply the regression coefficient b_2 found in Table A-1.

$$\frac{dG_i^t}{dREC_i^t} = b_2$$

While the purpose of this note is not to provide a discussion of goaling allocation procedures, it is interesting to note that the variables that are most significant in explaining the variance in the distribution of goals are the Navy Recruiter District (NRD) population, the number of recruiters, and the unemployment rate. These are the primary variables employed in the Navy Recruiting Command's (NRC's) goaling model. Note, however, that the sign associated with the ratio of civilian to military pay variable suggests that the higher this ratio, ceteris paribus, the higher the recruiting goal. This result is contrary to intuition since presumably the goals should be allocated to those regions with low civilian earnings. NRC's allocation model does not include a variable for civilian earnings. However, other variables (e.g., percent urbanization) are included that are strongly correlated with this ratio; hence, the positive relationship.

Table A-1

Goals: Regression Coefficients (b) and T-Ratios (t)

Item		1977 (1A.1)	1978 (1A.2)	1979 (1A.3)
Constant	b	-546.49*	-579.82*	-600.82*
	t	(1.903)	(2.982)	(3.347)
POP_i^t	b	0.00951*	0.00790*	0.012946*
	t	(3.159)	(3.940)	(5.457)
REC_i^t	b	22.941*	17.337*	12.997*
	t	(11.931)	(12.969)	(8.533)
UNR_i^t	b	-6.8533	28.828*	49.077*
	t	(0.411)	(2.085)	(2.605)
INT_i^t	b	1276.0*	109.03	409.09
	t	(1.680)	(0.239)	(0.774)
EMP_i^t	b	677.85	544.30	332.60
	t	(1.096)	(1.581)	(1.320)
PAY_i^t	b	40.234	48.553*	49.077*
	t	(1.259)	(2.666)	(2.605)
$\bar{R}^2$		0.964	0.975	0.953

*p < .05 (+ ≥ 1.65).

APPENDIX B

VARIABLES EXCLUDED FROM THE FINAL FORMULATION OF THE MODEL

VARIABLES EXCLUDED FROM THE FINAL FORMULATION OF THE MODEL

In an effort to estimate the effects of other service competition, variables measuring Army, Air Force, and Marine Corp enlistments were also included in the estimating equation. Without exception, the variables were statistically significant with positive coefficients. A negative coefficient had been expected; that is, the greater the number of enlistees to the other services, ceteris parabus, the fewer available to the Navy. Clearly, the other service accession variables are not capturing the desired effect of competition. Rather, since the recruiting environments may be favorable to many of the services in a particular area, there is a positive relationship between Navy and other service enlistments.

When various advertising variables were included in the estimating equation, the coefficients were not statistically significant. The Navy Recruiting Command allocates advertising expenditures roughly in proportion to the allocation of recruiters. The simple correlation between recruiters and advertising is .83. Thus, in aggregate models, it is not possible to accurately estimate the separate effects of recruiters and advertising because of the problem of multicollinearity.

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