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THE DETERMINANTS OF NAVY RECRUIT QUALITY: THEORY AND EVIDENCE 1--ETC(U)

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THE DETERMINANTS OF NAVY RECRUIT QUALITY: THEORY AND EVIDENCE 1970-1977

BY PETER M. GREENSTON AND RICHARD S. TOIKKA

TECHNICAL REPORT
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A model of the Navy recruitment process is developed and tested using 1970-77 quarterly data on recruits by mental category and education attainment. The model is based on a theory of selection by recruiters in which recruit quality is maximized subject to a quota filling constraint. Derived decision rules are applied to examine changes in recruitment standards in response to changes in the demand for accessions and the supply of recruits. Estimation of recruitment equations is carried out with variables measuring age eligibility, labor market conditions, financial incentives, and acceptance probabilities by quality group. Non-prior service male enlistment projections are made through 1994 under several unemployment scenarios.

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I. INTRODUCTION

This study was undertaken for the Office of Naval Research to determine the sensitivity of the quality and quantity of Navy recruits to economic factors in the Navy's recruiting environment. The analysis reported in the following pages considers the factors which affect the supply of potential recruits and also the process by which recruiting standards are set. A behavioral model of recruiter behavior is specified and tested using time series data on Navy recruits by test score and education.

It was our intention to be responsive to the Navy's need to understand their recruiting environment so that policies regarding the number of required accessions, pay, and recruitment standards can be made in such a way as to maximize the quality of recruits. The results of this research will be helpful to the Navy in two ways. First, a model of recruit quality can be used to assess the effectiveness of various policies in achieving maximum recruit quality. Since these policy decisions are played out in the Navy's recruiting environment, the effects of policies in differing environments can be explored. Second, the empirical model may be used to forecast the number and quality of recruits under various assumptions concerning the force level, compensation, population, and economic conditions in civilian labor markets. These forecasts can be used to estimate when shortfalls from recruiting quotas can be expected and to assess the consequences of improvement or deterioration in civilian labor market conditions on these shortfalls.

The Navy's recruitment process operates through the establishment of quantitative quotas. There are also certain quality "targets" such as a certain percentage of high school graduates which influence recruitment standards. The quantitative quotas are set by geographic area based on estimates of the numbers of qualified military available (QMA) by area. The basic data input in the process is Census population data. These data are augmented by internal Navy data on the proportion of the youth population which is expected to meet Navy recruitment standards.

The aggregate quotas are based on an assessment of the Navy's accession requirements. New accessions may be required because of retirements and other attrition as well as growth in total manpower requirements. Estimates of total force requirements are made on the basis of staffing requirements of Navy hardware. Then, attrition estimates are made using data on distribution of current force level by length of service and pay grade. Based on the force requirement and attrition estimates, an aggregate recruiting quota is derived. This aggregate quota then is apportioned by area based on estimates of QMA for each area.

With these recruitment quotas set and Navy compensation fixed in the short-run, the recruiter's decison problem is to meet the assigned quota subject to recruitment standards. Recruitment standards have historically been defined in dimensions of test score and educational attainment. There is evidence that military recruitment standards do respond to changes in the supply of recruits. The report of the Military Manpower Commission states:

> "The Services change their respective enlistment standards to insure that only applicants of the highest caliber are accepted for enlistment. Enlistment standards are raised when there is an abundance of applicants and lowered when the supply falls short of expectations.[1]

Recruitment standards respond to changes in relative supply of applicants only when the supply of applicants exceeds the quota. If the quota is greater than the available supply then a shortfall is inevitable. When the

1. Defense Manpower Commission, Report to the President and the Congress, April 1976, p. 200.

draft was in effect, the presence of draft motivated enlistments allowed the services to be selective in picking among the supply of recruits. In the all volunteer force (AVF) period this selectivity has still been possible to some degree because of an incresed recruiting effort by the services, an increase in military pay, and the lack of civilian job opportunities. A study of the quality of Air Force recruits (Cook and White, 1970) revealed that the average score on the Armed Forces Qualifying Test (AFQT) was sensitive to the relative supply of enlistees. This study presented quantitative evidence on the importance of short-run adjustments in recruitment standards on recruit quality. They estimate that a one percent change in the relative military-civilian pay ratio is associated with a .5 percent change in average AFQT score.

It is reasonable to believe that recruiting standards change in response to supply pressures. If recruiting quotas are viewed as requirements to be met in all but exceptional circumstances, recruiters have limited options to avoid a shortfall in circumstances of supply shortages. The following options are available and apparently in use. First, the Navy advertises and promotes its career opportunities to increase the supply of qualified recruits. Second, recruiters offer educational and assignment opportunities to prospective recruits as a means of enticing them to sign up. Both of these strategies increase the supply of applicants. However, there are budget and resource constraints on the utilization of these measures. Adver-[illegible] budgets are fixed in the short-run and the availability of assignments a[illegible]ucational opportunities will be limited both by the Navy's total resources and the commitments already made to other recruits and Navy personnel. If quotas are not met through enhancing supply, the most available recourse is to relax recruitment standards.

The incentive to relax recruiting standards operates in reverse when quotas stand to be exceeded. Opportunities then exist for saving resources on advertising and promotion, and for increasing the quality of recruits by taking applicants with more education and higher test scores.

In the sections of the paper that follow, a model of behavior by Navy recruiters is developed on the premise that recruitment standards shift to meet quantitative quotas in the short-run. This model is then stated in mathematical terms and estimated using time series data on Navy recruits by test score category and education. In section II, the behavioral model is presented. In section III, recruitment functions disaggregated by test score and education are estimated. In section IV, projections of enlistments by test score category and education are made under a set of assumption about youth unemployment and military pay. Finally, section V summarizes the study and its major conclusions.

II. A MODEL OF RECRUITMENT BEHAVIOR

The recruiter's decision problem can be represented as maximizing the quality of recruits subject to a quota filling requirement. Quality is not directly observed but is derived as the outcome of an evaluative process in which the recruiter combines available information on test scores, education, background, personality, etc. Additional inputs into this process are the recruiter's own judgment and experience. The perceived quality of a potential recruit (q) may be functionally related to a series of determinants. Denote those determinants by a vector $\underline{x} = (x_1, x_2, \ldots, x_n)$. The quality relation for an applicant may be written as:

$$q = q(\underline{x}) \tag{2.1}$$

The distribution of quality in the recruit population is derived from the joint distribution of the quality determinants ($\underline{x}$). Given that joint distribution $g(x_1, \ldots, x_n)$, and the quality relation $q(\underline{x})$, the marginal distribution of quality in the recruit population may be derived. This quality distribution will be denoted by $f(q)$.

If recruiters maximize recruit quality subject to a quota filling constraint, the decision problem may be represented formally as:

$$\max_{q_o} \; E(q \mid q > q_o) \tag{2.2}$$

$$\text{subject to } [E(R) - \bar{R} = 0]$$

where E is the expectations operator, R is the number of recruits, $\bar{R}$ is the quota, and q_o is the lowest acceptable level of recruit quality. The expected level of quality given an acceptance level q_o may be shown to be monotonically increasing in q_o (see Appendix C for a proof). The optimal strategy is to set q_o as high as possible subject to the quota filling constraint. The expected number of recruits E(R) is:

(2.3) $$E(R) = \left[\int_{q_o}^{\infty} f(q)dq \right] S$$

Since $\frac{\partial E(R)}{\partial q_o} = - f(q_o)S < 0$, the constraint $[E(R) - \bar{R}]$ is always binding. Substituting (2.3) into the constraint and dividing through by S indicates that the optimal value of q_o is a function of the ratio $\bar{R}/S$:

(2.4) $$\frac{\bar{R}}{S} - \int_{q_o}^{\infty} f(q)dq = 0$$

Solving (2.4) for q_o gives the optimal value q_o^*:

(2.5) $$q_o^* = q_o^* (\bar{R}/S)$$

and the optimal decision rule is

(2.6) $$\begin{cases} \text{accept } i \text{ if } q_i \geq q_o^* \\ \text{reject } i\text{, otherwise} \end{cases}$$

It can be seen from equation (2.5) that recruitment standards adjust in this model in response to changes in the ratio of the quota mandated accessions $\bar{R}$ to the total supply of potential recruits S. Differentiating (2.4) gives the partial derivative

(2.7) $$\frac{\partial q_o}{\partial(R^*/S)} = - \frac{1}{f(q_o)} < 0$$

The negative sign of the partial derivative indicates that a statically optimal strategy is to set recruitment standards low when the quota is large relative to the available supply of recruits and to set it high when the quota is small relative to the supply.

The consequences of this behavior for recruit quality can be assessed directly by observing the effect of truncating the distribution of recruits by quality. The truncated distribution becomes

$$(2.8) \qquad f(q|q>q_o) = \int_{q_o}^{\infty} f(q)dq \text{ for } q > q_o$$

$$0 \quad \text{otherwise}$$

The moments of the distribution may be derived by integration. One result of particular interest is how changes in the recruiting quota and the supply of recruits affect the average quality of recruits. The expected value of the truncated quality distribution is given by

$$(2.9) \qquad E(q|q > q_o) = \int_{q_o(\bar{R}/S)}^{\infty} q \quad f(q|q > q_o)dq = \frac{\int_{q_o(\bar{R}/S)}^{\infty} q \, f(q)dq}{\int_{q_o(\bar{R}/S)}^{\infty} f(q)dq}$$

The partial derivative of expected quality with respect to the quota-supply ratio $\bar{R}/S$ is

$$(2.10) \qquad \frac{\partial E(q|q > q_o)}{\partial(\bar{R}/S)} = \frac{\partial E(q|q > q_o)}{\partial q_o} \quad \frac{\partial q_o}{\partial(\bar{R}/S)} < 0$$

The effect of the quota-supply ratio on average quality is the product of two partial effects: first, the effect of the quota-supply ratio on the recruitment standard q_o which has been shown to be negative and the effect of the recruitment standard on average quality which is shown in the appendix to be positive. Thus, the quota-supply ratio is inversely related to average recruit quality under the quality maximization decision rule examined in this paper.

Quality in the sense defined by equation (2.1) is not likely to be observed since it is the result of a judgmental process. If the arguments of the quality function are known, however, tests of the validity of this theory may be carried out using data on those variables. Changes in recruitment standards will be reflected in the distribution of recruits by characteristics in the quality function. For example, if test score is positively correlated with perceived quality then a lowering of the recruiting standard would be expected to result in an increase in the relative number of recruits with low test scores and a decrease in the relative number with high test scores.

The expected number of recruits with a particular set of characteristics represented by vector $\underline{x}^*$, where $\underline{x}^*$ contains a subset of the elements in vector $\underline{x}$, can be expressed by a conditional recruitment function defined as

$$E(R|\underline{x}^*) = s(\underline{x}^*) \int_{q_o}^{\infty} f(q|\underline{x}^*)dq \tag{2.11}$$

where $s(\underline{x}^*)$ is the supply of recruits with characteristics $\underline{x}^*$ and $f(q|\underline{x}^*)$ is the conditional distribution of q in the population of recruits with characteristics $\underline{x}^*$.[1] Total expected applicants (S) is given by

$$S = \int_{-\infty}^{\infty} \cdots \int_{-\infty}^{\infty} s(\underline{x}^*)g(\underline{x}^*)d\underline{x}^* \tag{2.12}$$

By differentiating (2.11) the effects of the quota $\bar{R}$ and the supply of enlistees S on the conditional mean functions can be determined. The derivative with respect to the quota $\bar{R}$ is

$$\begin{aligned} \frac{dE(R|\underline{x}^*)}{d\bar{R}} &= \frac{\partial E(R|\underline{x}^*)}{\partial q_o} \frac{\partial q_o}{\partial \bar{R}} \\ &= \frac{f(q^o|\underline{x}^*)s(\underline{x}^*)}{f(q_o)\, S} > 0 \end{aligned} \tag{2.13}$$

1. Note that if $\underline{x}^* = \underline{x}$, i.e., contained all of the elements in vector x, $g(q|\underline{x}^*) = 1$, and there is no variation in quality. The randomness in quality depends on variables which are omitted from $\underline{x}^*$.

The positive sign of the partial derivative indicates that the expected number of recruits is positively correlated with the size of the quota. This positive effect holds for all values of $\underline{x}^*$ (all quality levels). When the quota increases (decreases) recruitment standards fall (rise), thus causing the number of recruits in all quality categories to increase (decrease).

The effect of recruitment supply on the expected number of recruits with a particular set of characteristics $\underline{x}^*$ can be seen in the derivative

$$\frac{dE(R|\underline{x}^*)}{dS} = \frac{\partial E(R|\underline{x}^*)}{\partial q_o} \frac{\partial q_o}{\partial S} + \frac{E(R|\underline{x}^*)}{\partial S}$$

$$(2.14) \qquad = - \frac{s(\underline{x}^*)}{\partial S} \frac{f(q_o|\underline{x}^*)}{f(q_o)} \int_{q_o}^{\infty} f(q)dq$$

$$+ \frac{\partial s(\underline{x}^*)}{\partial S} \int_{q_o}^{\infty} f(q|\underline{x}^*)dq$$

This derivative cannot be signed. The first term on the RHS is negative and the second term will generally be positive (if $\frac{\partial s(\underline{x}^*)}{\partial S} > 0$). A moment's reflection gives us the reason for the indeterminacy. As aggregate supply increases (decreases), recruitment standards rise (fall). The changes in recruitment standards have different impacts on the flow of recruits at different points on the quality spectrum. For example, lowering recruitment standards will tend to increase the number of low quality recruits and decrease the number of high qualtiy recruits. With the quota fixed, the effect of changes in recruitment standards is to redistribute recruits along the quality spectrum. Thus, the sign of the expression on the RHS of (2.14) will be positive where the flow of relatively high qualtiy recruits increases in response to raised recruitment standards, and negative where the flow of relatively low quality recruits decreases in response to raised recruitment standards.

Under certain conditions which are derived in the appendix, the marginal impact of supply of the expected number of recruits at any combination of characteristics $\underline{x}^*$ increases smoothly, being negative and large at values of $\underline{x}^*$ corresponding to very low quality and becoming positive and large at values of $\underline{x}^*$ corresponding to very high quality. These conditions are likely to be met if $\underline{x}^*$ is strongly correlated with the probability of acceptance into the service.

In section III, the implications of this model of recruitment behavior will be tested using data on Navy recruits by test score and education. Before that can be accomplished the model must be made operational in terms of the data which will be used. The quality function will be written with x_1 and x_2 defined as test score and education resulting in

$$(2.15) \qquad q = q(x_1, x_2, x_n) = q(\underline{x}^*, \underline{x})$$

where x_n is a vector of determinants of quality other than education and test score. The expected number of recruits in the i^{th} education-test score category (r_i) may be written as

$$(2.16) \qquad r_i = S_i \int_{q_o}^{\infty} f(q|x_1, x_2)dq = S_i P_i$$

where S_i is the enlistee supply in the i^{th} category, and P_i is the probability of an applicant in the i^{th} category being accepted. The probability of acceptance may be approximated by an n^{th} order polynomial in logarithms of the quota/aggregate supply ratio of the form

$$(2.17) \qquad P_i = e^{\sum_{j=1}^{n} \beta_{ij} \ln(\bar{R}|S)^j}$$

Substituting (2.17) into (2.16) and taking natural logarithms of both sides of the resulting equation gives

$$(2.18) \qquad \ell n\, r_i = \ell n\, S_i + \sum_{j=1}^{n} \beta_{ij} \ell n(R|S)^j$$

There are a number of models of recruit supply in the literature which can be tested using the structure of (2.18). Suppose the determinants of supply in the i^{th} category are the m elements in vector $(Z_1, \ldots, Z_k)$ which are related to supply by a constant elasticity function

$$(2.19) \qquad S_i = \prod_{k=1}^{m} Z_k^{\alpha_{ik}}$$

or in logarithms

$$(2.20) \qquad \ell n\, S_i = \sum_{k=1}^{m} \alpha_{ik}\, \ell n\, Z_k$$

Substituting (2.20) into (2.18) gives the estimable function:

$$(2.21) \qquad \ell n\, r_i = \sum_{k=1}^{m} \alpha_{ik}\, \ell n\, Z_j + \sum_{j=1}^{n} \beta_{ij} \ell n(R|S)^j$$

This function will provide the theoretical basis for the empirical estimation reported.

III. ENLISTMENT ESTIMATION

A. OVERVIEW

The enlistment equations estimation (described below) is based on quarterly observations beginning 1970III and running through 1977IV. We begin at this point because the intent is to examine enlistment behavior primarily under the All Volunteer Force, and because earlier data do not permit a breakdown of mental category by educational attainment--information crucial to an examination of the enlistment quality adjustments hypothesized in the framework. There are six enlistee groups: mental categories I-II, III, and IV, each in turn comprised of those who are high school graduates (HSG) and those who are not (NHSG).

In the view taken here, enlistments represent a selection by the military from a supply of applicants. Though the supply is not observable, variation in it can be represented by variation in its determinants; these factors, together with proxies for the military's demand by quality category, explain the number of enlistments in each group.

The enlistment supply model embedded in the quality adjustment framework is based on an economic theory of occupational choice. In making their decision, potential enlistees evaluate the financial returns and other advantages as well as disadvantages to military service versus civilian alternatives. In the set of variables selected to capture these factors, we follow previous empirical work fairly closely. Financial returns are reflected by military and civilian pay. In choosing not to enlist, the potential enlistee also must consider the likelihood of being unemployed and accordingly without earnings. Tastes or preferences as between these two modes undoubtedly play a significant role, and are assumed to be affected by factors such as prestige of the military, family military background, military discipline, risk of injury and death, etc.

The aggregate supply of applicants will depend upon the distribution of civilian earnings alternatives and preferences for civilian vis-a-vis military living. Under a set of plausible assumptions and inferences about the shape of this distribution, non-linear enlistment rate equations have been derived and estimated by other researchers for so-called supply determined categories.[1]

In carrying out the empirical work, we specifically examine (i) the role of the eligible pool and the reasonableness of assuming a unitary pool elasticity as embodied in enlistment rate estimations; (ii) the formation of expectations about financial returns and unemployment variables; (iii) the usefulness of a seasonality indicator, and its interaction with other factors; (iv) the measurement of financial returns with relative vis-a-vis absolute earnings formulations; and (v) the role of several measures of unemployment in affecting civilian alternatives.

In the next section, we briefly describe the data and the movement of enlistments and the explanatory factors over the period. Estimation technique, results, and comparative analyses are presented in the third section.

B. ENLISTMENTS, ELIGIBLES, PAY, AND UNEMPLOYMENT, 1970-77

Enlistments by mental category and high school graduate status are based on monthly data reported by the Defense Manpower Data Center. These data have been adjusted to exclude reservists and draft-motivated enlistments, and corrected to reflect the cheating in the mental category testing which occurred in 1973-74.[2] Over the entire period, total enlistments (as defined above)

1. See, for example, Fisher, "The Cost of the Draft and the Cost of Ending the Draft," American Economic Review 59, June 1969, pp. 239-255.
2. Data sources and methods of adjustment are described in detail for all the variables in the Appendix.

have alternately increased and decreased from year to year, with perhaps some upward trend but they have not re-attained the level of 1972 (see Table 1). The share of I-II enlistments has fluctuated (between 31 and 48 percent), for the most part moving inversely to total enlistments; however, in 1975 and especially 1976 the increase in I-II's share is quite dramatic. Category III shares were constant for 1971-74, but markedly increased during 1975-77, largely at the expense of category IV enlistments which fell to less than 5 percent during this time (see Figure 1).

Among the I-II enlistments, the ratio of HSG to NHSG has fallen from around 8:1 to 5:1 (see Table 1), the large increase in the I-II share for 1976 arose in part from more NHSG's, while the subsequent decline in 1977 was not matched by a corresponding fall in NHSG's. During the early years while the share of III enlistments were constant, the proportion of HSG's fell from almost 3:1 to 1:1; the subsequent increase in the share of III's was achieved with a return to higher HSG proportions. The decline in IV enlistments has resulted in a drop off in the relative as well as absolute number of NHSG's accepted.

Measurement of the eligible pool is confined to youth 17-21 years of age who are not enrolled in school. We distinguish two pools--those who are high school graduates and those who dropped out before graduation. The graduate group increased quite steadily from 1970-75 and has subsequently levelled off, while drop-outs have increased less smoothly over the period, even registering a small decline in 1975 (see Figure 2).

The financial returns to the civilian alternative is estimated by the sum of four years of full-time income for 18-21 year-old male workers. Four years' worth of base pay by the enlistee making average progress through the ranks is used as an indicator of military compensation. Estimates of quarters and subsistence allowances, as well as tax advantages, are not included because they have changed relatively little in real terms over the period. The comparisons can be confined to four years under the assumption that earnings of veterans and non-veterans are similar. Furthermore, discounting is not necessary under the assumption that the earnings profiles are similar over time. Both indicators are expressed in real (1958) dollars and are shown in Figure 3. Real civilian pay has oscillated, while military pay jumped in 1971, and has declined subsequently.

Unemployment rates are used in the calculation of expected civilian earnings to account for the likelihood of unemployment, and also as an indicator of the viability of civilian employment alternatives in the first place. We experiment with measures for 16-19 year old males in the labor force, and 20-24 year olds to reduce the simultaneity between enlistments and unemployment rates. In addition to seasonal variation in the rates (highs in the first and lows in the third quarters), they fell somewhat in 1973-74, and then jumped in 1975-76 to an average of almost 20 percent for 16-19 year olds (Figure 4).

Table 1

Enlistments by Mental Category and Education

Calendar Year	Total	Mental Category		
		I-II	III	IV
	(1,000's)	Percent		
1971	64.5	38	44	18
1972	88.8	31	44	25
1973	65.9	39	44	17
1974	82.4	34	39	27
1975	70.7	42	53	5
1976	80.9	48	49	3
1977	75.2	39	58	3
		(Ratio of HSG to NHSG)		
1971		10.5	2.7	1.7
1972		8.0	1.9	.9
1973		8.3	1.4	7.8
1974		5.5	.9	32.5
1975		7.9	2.9	34.8
1976		3.9	1.7	24.8
1977		4.9	2.0	11.4

Figure 1

Shares by Mental Category

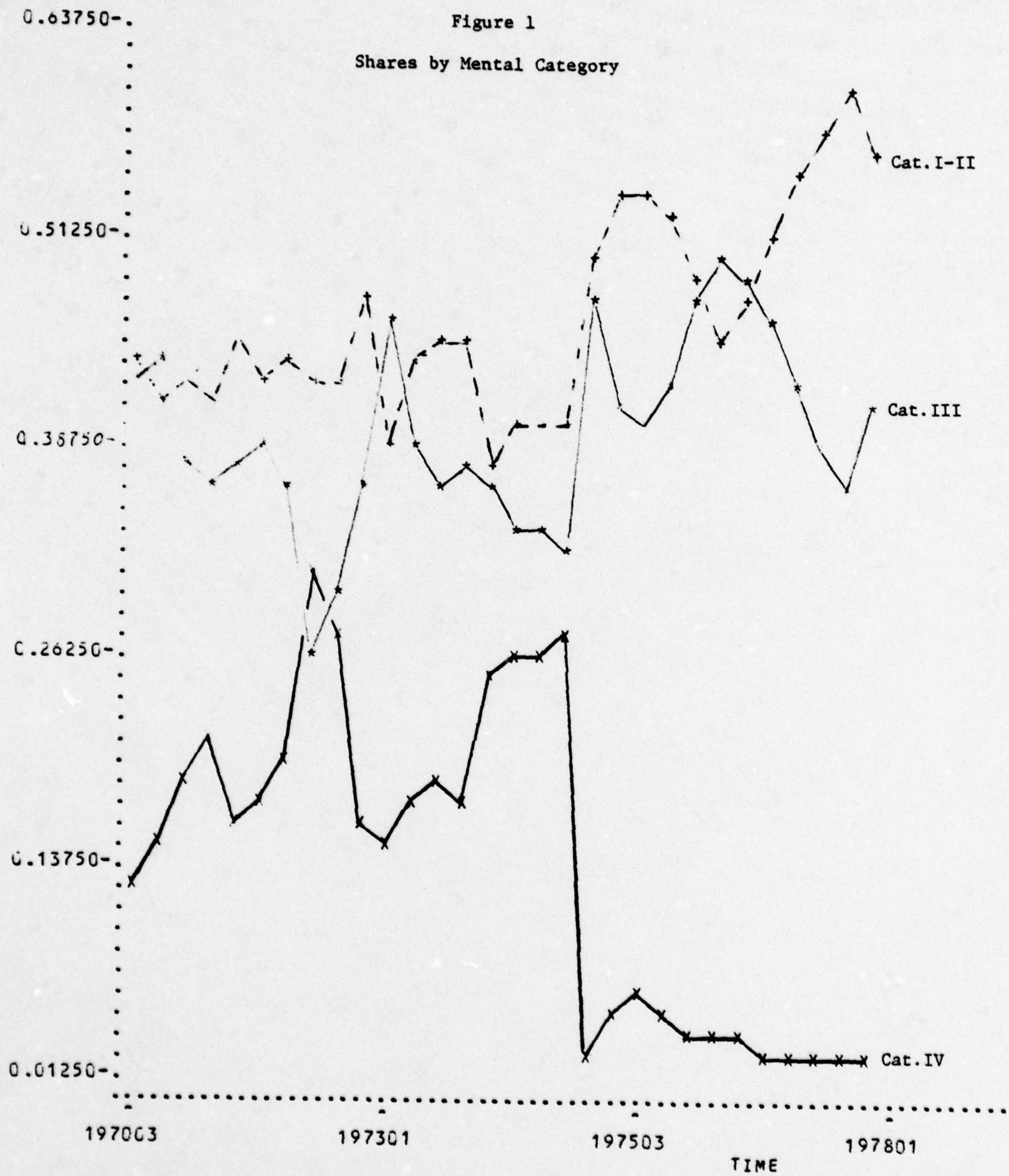


Figure 2

Eligible Pool: Males Not Enrolled in School (1000's)

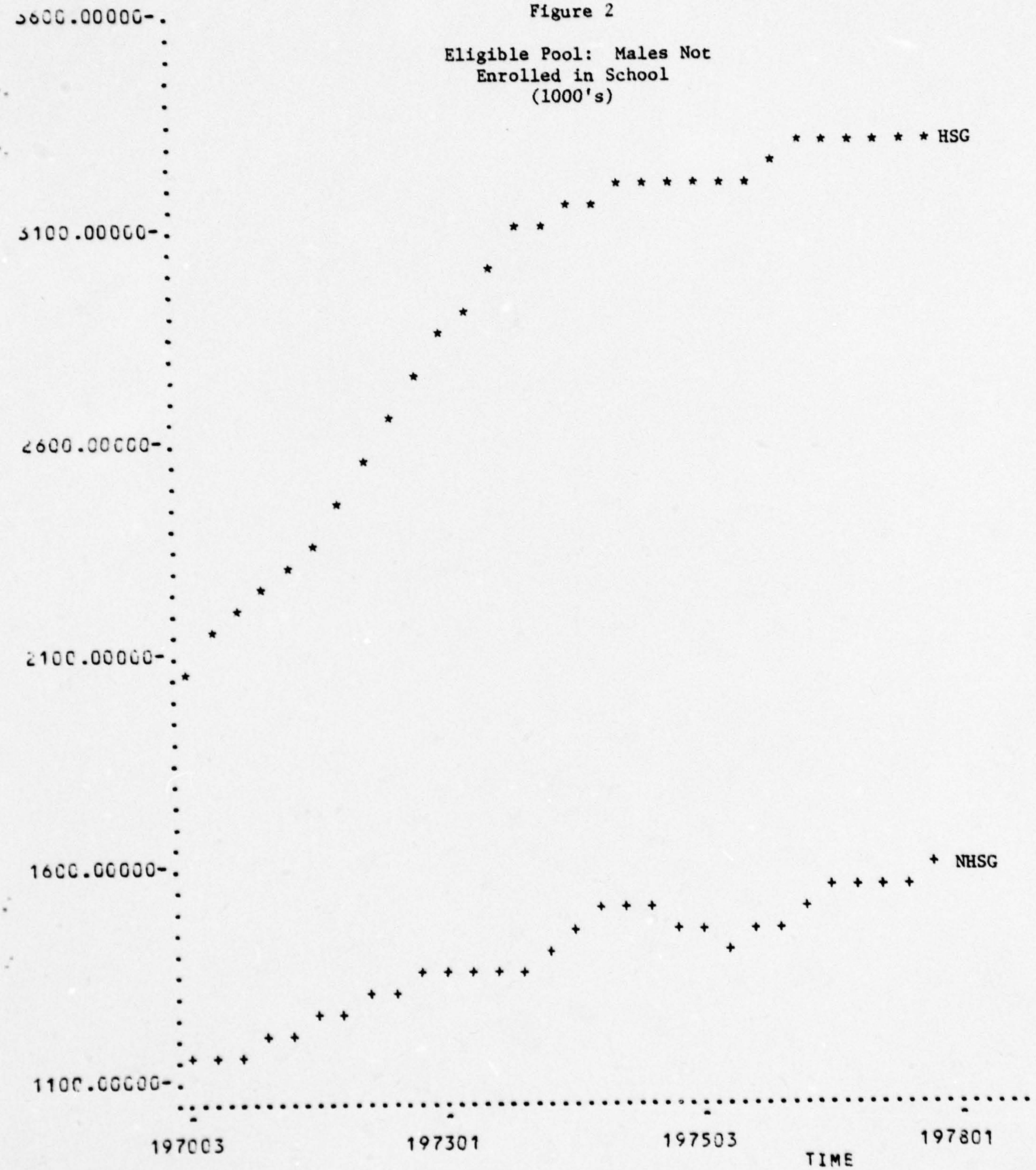


Figure 3

Military and Civilian Pay
(1958 dollars)

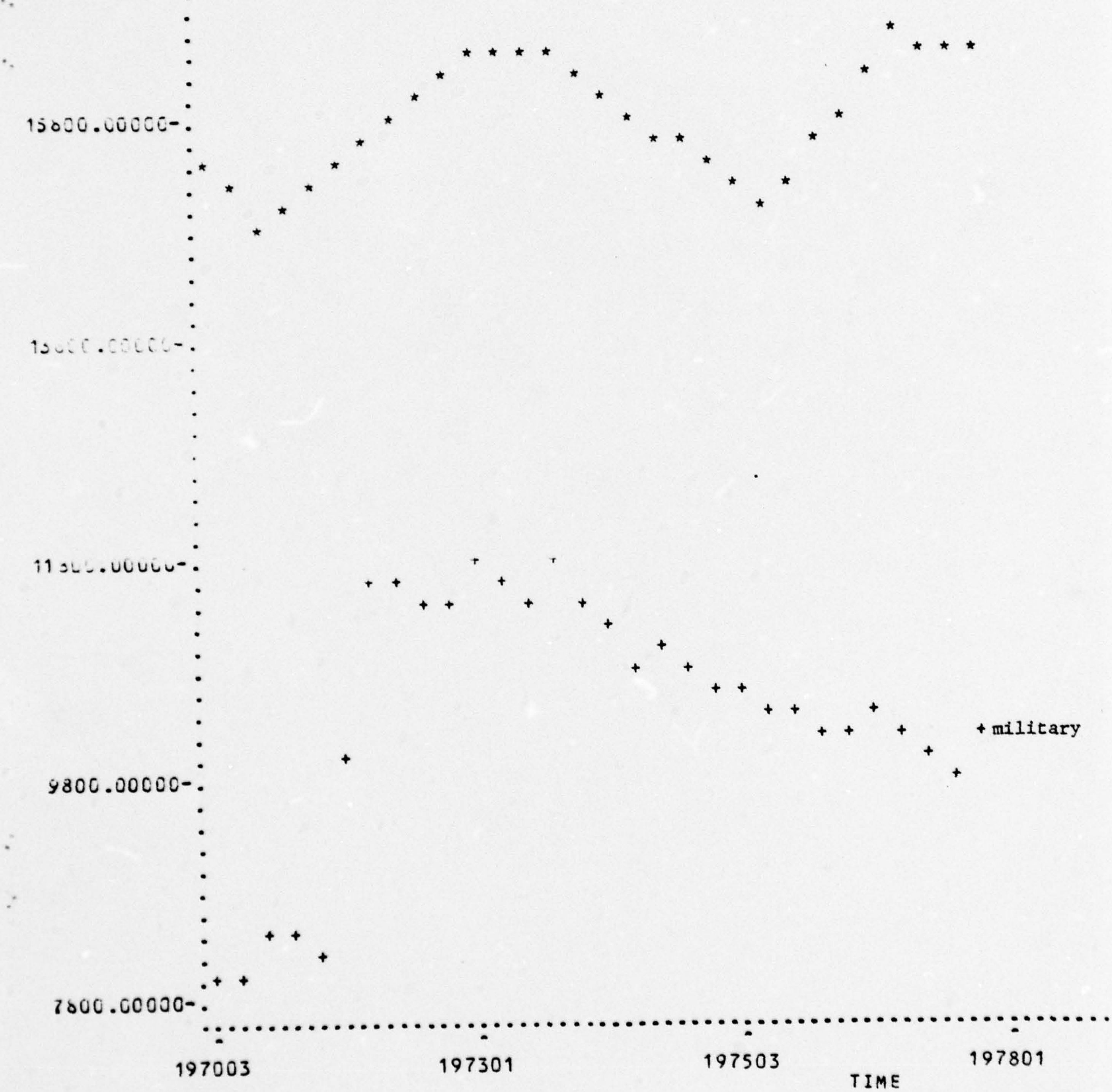
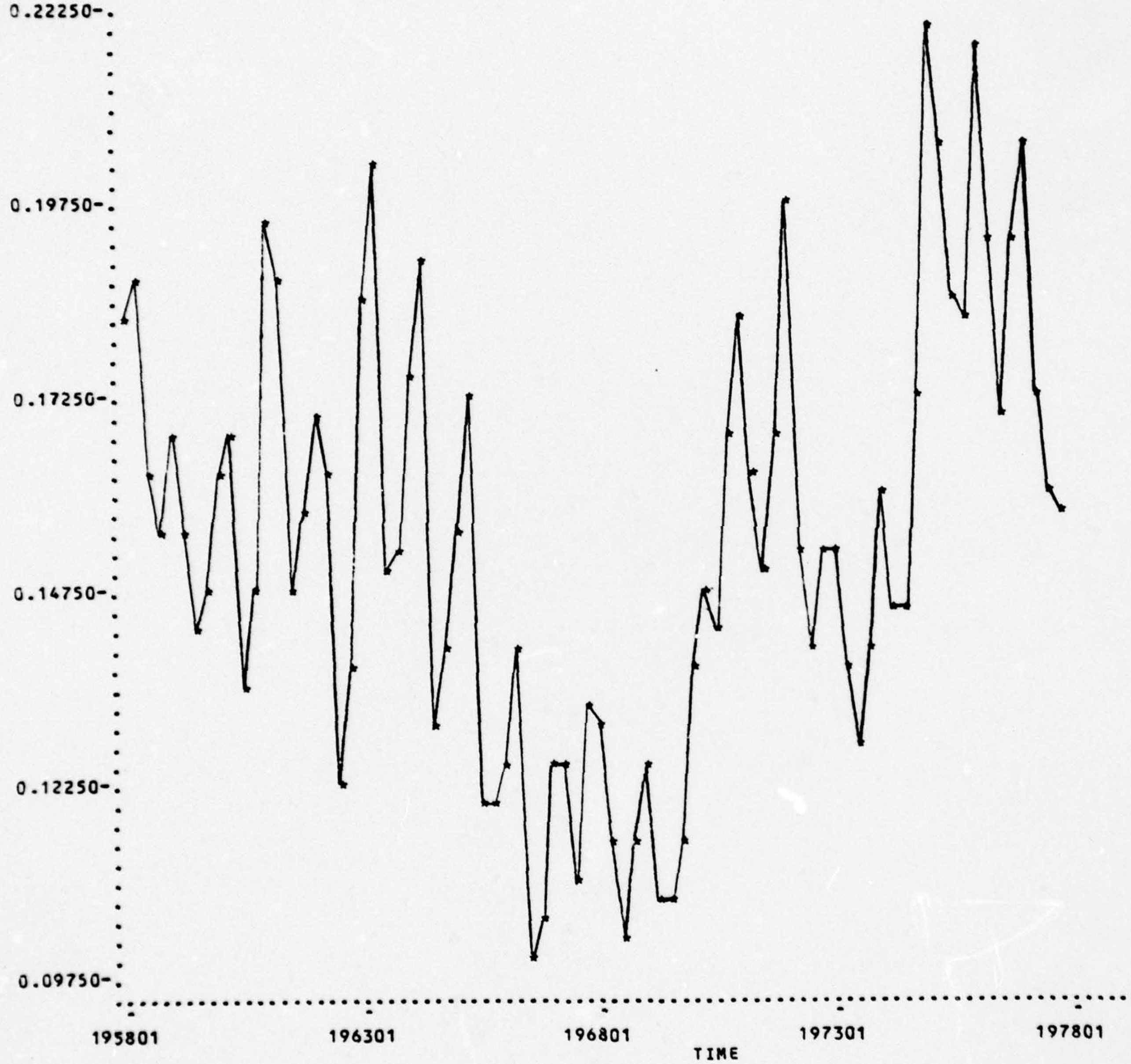


Figure 4

Unemployment Rate
Males, 16-19 Years Old



C. RESULTS

In the framework developed above, for each mental category-education group, enlistments can be estimated as the product of an acceptance probability and a supply of potential enlistees (applicants). Since supply is not observable, we employ a proxy linear-in-logs expression comprised of those factors (Z_m) hypothesized to determine supply:

$$\ell n\, S_i = \alpha_{io} + \alpha_{i1}\, \ell n\, Z_1 + \cdots\, \alpha_{im}\, \ell n\, Z_m. \tag{2.20}$$

With acceptance probabilities given by (2.17), the six recruit equations

$$\ell n\, r_i = \sum_m \alpha_{im}\, \ell n\, Z_m + \sum_j \beta_{ij} [\ell n(R/\hat{S})]^j \tag{2.21}$$

will be estimated.

Before proceeding with the estimation, an estimate of aggregate supply is needed.[1] First, if we assume that all the I-IIHSG applicants are accepted, $\hat{S}_1$ can be effectively predicted by a regression (2.21) with the probability of acceptance equal to unity (i.e., $\sum_j \beta_{ij} [\ell n\, R/S]^j = 0$). Since the acceptance probability for category I-IIHSG exceeds those for other groups, the ratio of I-IIHSG applicants to total applicants (the supply share) is less than the ratio of I-IIHSG recruits to total recruits (the recruit share). As an approximation, the supply share (which is not observable) is taken as 85 percent of the recruit share (which is observable), and $\hat{S}$ is estimated by scaling up I-II HSG recruits by the reciprocal of the estimated supply share. Finally, for one quarter the estimate of $\hat{S}$ falls short of $\bar{R}$; for this period we increase $\hat{S}$ to $\bar{R}$. We also note that recruitment quota data are not available for the entire period; hence, we assume that quotas were always met and use total enlistment as a proxy.

1. Ideally, the estimation of aggregate supply should be obtained in an iterative procedure, in which, having selected an initial value, the equations are used to predict successive estimates. The procedure is stopped when the estimated coefficients converge to a single set of values. Since we were unable to obtain convergence, we used the approximation described above.

For the "basic" model, regression results are presented in Table 2. Embedded in the enlistment equations are these (hypothesized) determinants of supply: (i) current eligible pool (EL--4 for HSG and 5 for NHSG), (ii) real civilian expected earnings lagged one period (W^c), (iii) real military base pay lagged two periods (W^m), (iv) the 16-19 year-old unemployment rate lagged two periods (U), and (v) seasonal dummies (S1, S2, S3) which capture the "schooling cycle" of enlistments. All variables are expressed in logarithms. This lag structure conformed closest to our prior expectations about these determinants, and is compatible with an enlistment decision-making period of approximately 4-6 months. We also experimented with several adaptive expectations formulations where expected pay and unemployment, upon which the (current) enlistment decision is made, are measured as weighted averages of previous values with more recent experience being more important. The findings were similar and are reported in Table A-1. Delayed entry pool enlistments compound the difficulty of modelling the decision-making period.

The estimated probabilities of acceptance are reported in Table 3. For the NHSG groups, these estimates regularly exceed unity, suggesting that we are underestimating supply for these groups. For Cat.III HSG the estimates range between .73 and .99, with a median value of .92; for Cat.IV HSG the range is .49 to .92, with a median value of .60.

In a comparison of the impact of supply factors across groups, there are similarities between mental category groups and differences within them by education group. Eligible pool size and unemployment are the dominant factors in Cat.I-II and Cat.III, with unemployment more important for the HSG groups and pool size more important for the NHSG groups. Military pay seems to play a stronger role among the lower mental categories.

Table 2

Enlistment Equation Results
Basic Model[1]
Cat.I-II, III, IV Groups

	I-II		III		IV		I-II	III	IV
	HSG	NHSG	HSG	NHSG	HSG	NHSG			
C	11.02[b]	-.86	5.12	-23.03[b]	.74	-3.95	10.90	-2.26	11.91
EL	.22	2.77[c]	.08	1.28[a]	(-3.53)[c]	(-19.30)[c]	.55[a]	.52	(-6.74)[c]
U (-2)	.54[b]	.12	1.83[c]	.39	(-2.54)[a]	3.99[a]	.45[a]	1.19[c]	(-1.42)
W^M (-2)	.46	.38	(-.05)	.96[a]	5.08[c]	2.30	.36	.24	5.63[c]
W^c (-1)	-.78	-1.67	(.69)	(1.43)	-1.76	(14.16)[c]	-.99	(.73)	-.25
RS1	-	-.96	.48	-.67	4.65	-5.06	-	.07	3.58
RS2	-	-3.99	-.86	-3.69	7.56	-18.43	-	-1.83	4.75
S1	.09	.06	.08	.09	-.20	.33	.09	.06	-.11
S2	-.06	-.07	.08	-.03	.20	.91[a]	-.06	.03	.27
S3	.38[c]	.29	.38[c]	.27[a]	.75[c]	-.18	.38[c]	.35[c]	.59[a]
R^2(corr.)	.74	.31	.80	.50	.42	.70	.74	.80	.52
F	13.06	2.47	14.03	4.24	3.30	8.43	12.69	14.10	4.49
D-W	2.03	1.14	1.38	1.96	1.12	1.25	2.06	2.00	1.10

Note: Coeffs. significantly greater or less than zero at .10 (a) level, .05 (b) level, .025 (c) level; coeffs. with "wrong" sign are shown in parentheses.

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1. All variables are in logarithms
   EL: eligible pool
   U: unemployment rate
   W^M: real military basic pay
   W^c: real expected civilian earnings
   RS1: $\ln \bar{R}/\hat{S}$
   RS2: $(\ln \bar{R}/\hat{S})^2$
   S1:, S2:, S3: seasonal dummies

Table 3

Estimated Acceptance Probabilities
by Mental Category--Education Groups

	Cat.III		Cat.IV	
	All	HSG	All	HSG
197003	0.88	0.84	0.55	0.50
197004	0.89	0.86	0.57	0.51
197101	0.99	0.97	0.83	0.78
197102	0.80	0.78	0.51	0.49
197103	0.97	0.94	0.71	0.66
197104	1.00	0.99	0.93	0.92
197201	1.00	0.97	0.84	0.80
197202	0.87	0.83	0.54	0.50
197203	0.96	0.93	0.69	0.63
197204	0.97	0.93	0.70	0.64
197301	0.91	0.87	0.58	0.52
197302	0.99	0.98	0.87	0.84
197303	0.98	0.95	0.76	0.71
197304	0.75	0.74	0.51	0.51
197401	0.95	0.92	0.66	0.60
197402	0.96	0.93	9.69	0.63
197403	0.94	0.90	0.63	0.57
197404	0.98	0.96	0.78	0.73
197501	0.89	0.85	0.56	0.51
197502	0.99	0.97	0.81	0.77
197503	0.75	0.74	0.51	0.51
197504	0.94	0.90	0.63	0.57
197601	0.83	0.80	0.52	0.49
197602	0.98	0.95	0.74	0.69
197603	1.00	0.99	0.91	0.89
197604	1.00	1.00	1.00	1.00
197701	0.95	0.92	0.66	0.60
197702	0.90	0.86	0.57	0.52
197703	0.94	0.91	0.64	0.58
197704	0.74	0.73	0.51	0.51

In terms of explanatory power, we have done better with the HSG groups (except for Cat.IV). Tests for the absence of serial correlation are inconclusive for all groups except for Cat.I-II HSG.

As an aid in interpreting the multivariate results, simple correlations among the explanatory variables are presented below.

	EL4	EL5	$W^c(-1)$	$W^M(-2)$	U(-2)	S1	S2
$W^c(-1)$	.11	.09					
$W^M(-2)$	.77	.66	.42				
U(-2)	.34	.39	-.55	.03			
S1	-.00	-.02	-.02	-.09	-.35		
S2	.05	.05	-.30	.06	.03	-.30	
S3	-.06	-.05	.07	.06	.37	-.33	-.33

In the estimation multicollinearity does not seem to have been a problem. Simple correlations among the explanatory variables were generally low, with the exception of eligible pool and military pay (with values of .77 for HSG and .65 for NHSG).

The regressions indicate that Cat.I-II and III enlistments move with eligible pool size changes. The relationships are considerably stronger for the NHSG groups, with elasticities exceeding unity (significantly so for the I-II NHSG group); the HSG pool elasticities are positive but small, and insignificantly different from zero. Thus (at this disaggregated level), there is no support for the usual practice of accounting for the effect of pool size by using the ratio of enlistments to pool as the dependent variable. Moreover, even if the groups are combined across education categories, the resultant pool elasticity estimates are approximately 0.50. The implication of these results for forecasting is that the impact upon enlistments of a declining eligible pool will not be as severe overall, and especially not for the HSG groups.

The tendency of Cat.IV enlistments to decline with increases in the eligible pool may reflect the recruit quality upgrading that occurred as the eligible pool grew. With a better model of the enlistment process, this behavior would be captured by demand factors, and Cat.IV enlistments would move with the eligible pool, as well as the unemployment rate (see below).

In examining the impact of military pay upon applicant supply, a lag of either one or two periods produced similar results and was found preferred to a contemporaneous formulation. Estimated impacts were positive for all groups (except for Cat.III HSG) but statistically different from zero for only two groups (Cat.III NHSG and Cat.IV HSG). Estimated elasticities are 0.46 and 0.38 for the Cat.I-II groups, and 0.96 for Cat.III NHSG. Ignoring the large Cat.IV elasticities, these estimates are smaller than those commonly assumed in forecasting. If the groups are combined on education, the same picture emerges.

The variable performing the least satisfactorily is civilian earnings. We experimented with both a regular measure and an expected earnings version; they both produced basically the same results. Early in the experimentation, it became clear that the variable had to be lagged to produce the expected impact; lags of more than one period sometimes produced extremely large impacts. For the groups where it "worked" (I-IIHSG, I-IINHSG, IVHSG), the impacts are never significantly different from zero.

The pay variables operated together with the expected impact for only the Cat.I-II groups and Cat.IV HSG groups. Even though these estimates are not particularly reliable, they do suggest that the military pay impact may be less than the civilian pay impact,[1] and that formulations with relative pay may not be appropriate. Nevertheless, estimated relative pay elasticities

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1. Fechter found similar relative magnitudes, and also determined that including in-kind pay did not markedly increase the military pay elasticity in his semi-log formulation; see his "An Evaluation of Enlistment Supply in a No-Draft Environment," paper prepared for Atlantic Economic Society, Fourth Annual Conference, Washington, D.C., October 1976, pp. 10, 24-25.

are presented in Table A-2. From the Cat.I-II HSG group, we see that the relative estimate is between the absolute estimates; comparisons for other groups are difficult to make.

Enlistments increase with increases in the youth unemployment rate for all groups (except for Cat.IV HSG). Moreover, the impact is statistically significantly greater than zero for Cat.I-II HSG and Cat.III HSG. In fact, for the latter group it is significantly greater than unity. The observed effect for Cat.IV HSG suggests that increasing unemployment is associated with larger shares of Cat.I-II and Cat.III among enlistments, and correspondingly with fewer Cat.IV's. Once again, successful modelling of the demand process would allow us to estimate a positive supply relation between unemployment and Cat.IV enlistments.

We also experimented with unemployment rates for 20-24 year olds, and obtained similar results, suggesting that simultaneity between enlistments and unemployment is not a serious problem. Duration of unemployment and the product of rate and duration were also used as alternative measures and produced similar results.

The equations were also estimated with the seasonal dummies excluded (see Table A-3). Probably the most interesting finding was that the exclusion markedly reduced the explanatory power of the HSG groups, but did not affect that of the NHSG groups. This suggests the obvious: the school cycle as a determinant of enlistments is important primarily for those intending to graduate. Without seasonal dummies, unemployment and miliary pay impacts are boosted for all groups (except Cat.IVNHSG), while that of eligible pool size is reduced (perhaps due to its correlation with military pay).

IV. PROJECTIONS

To meet the total manpower quotas, we have hypothesized that recruiters adjust acceptance probabilities: when quotas vis-a-vis applicant supply are tight (loose), acceptance probabilities tend to increase (decrease) and the resulting quality composition of enlistments tends to worsen (improve). The initial purpose of this section was to simulate this process--to describe how quality would change to meet quotas under different futures. In projecting the supply of applicants for the 1979-1994 period, however, it has become clear that the Navy will be pushed towards 100 percent acceptance rates while still falling short of requirements. The simulation results reported here are based on an assumption that acceptance probabilities equal one for every group. As a consequence, the variation in enlistments and its quality composition described below stems from alternative futures as well as group differences in the response of enlistments to the determinants of supply, and not from adjustments in quality standards.

Underlying the projections reported in this section are the following assumptions about future values of the supply determinants:

(1) The basis of eligible pool projections are Bureau of the Census Series II 17-21 year-old male population projections through 1994; these are adjusted to exclude the armed forces and the institutionalized. High school graduation rates are assumed to remain constant (as they have been over the 1970's), and college entrance rates which have fallen over the decade are assumed to stabilize at 1977 levels. In consequence, the high school graduate pool is projected to decline from 3,280 thousand in 1978, to 2,967 thousand by the end of 1985, and to 2,435 thousand by

1994. Corresponding projections for the non-high-school graduate pool are 1,580, 1,398, and 1,176 thousands.

(2) Real civilian earnings are projected to grow at an annual rate of 2.5 percent, corresponding to the long-term rate of productivity growth.

(3) Real military pay can be treated as a policy variable. The status quo assumption is that it keeps pace with civilian earnings which, because of the difference in elasticities, would imply (other things equal) falling enlistments.

(4) Several alternative assumptions are made about unemployment (see below).

The simulation equations presented in Table 4 were re-estimated and include only variables with the theoretically correct sign. Projections for the NHSG groups are derived as the difference between "all group" and HSG projections.

Projected requirements through 1985 are those estimated by the Congressional Budget Office[1] (see Table 4). Three scenarios are examined through 1994; they differ according to future unemployment rates as follows:

A. 1977 unemployment rates continue to prevail.

B. Unemployment rates improve to 1968-69 levels by 1985 and continue at that level through 1994.

C. Unemployment rates worsen to 1975 levels by 1985 and continue at that level through 1994.

These projected rates are depicted in Figure 5A, 5B, and 5C.

1. Nelson, Hale, and Hamilton, "The Costs of Defense Manpower: Issues for 1977," Congressional Budget Office, January 1977, Table A-5. Note that estimates for 1983-1985 represent an average of projected needs for 1979 through 1982.

Table 4

Simulation Model[a]

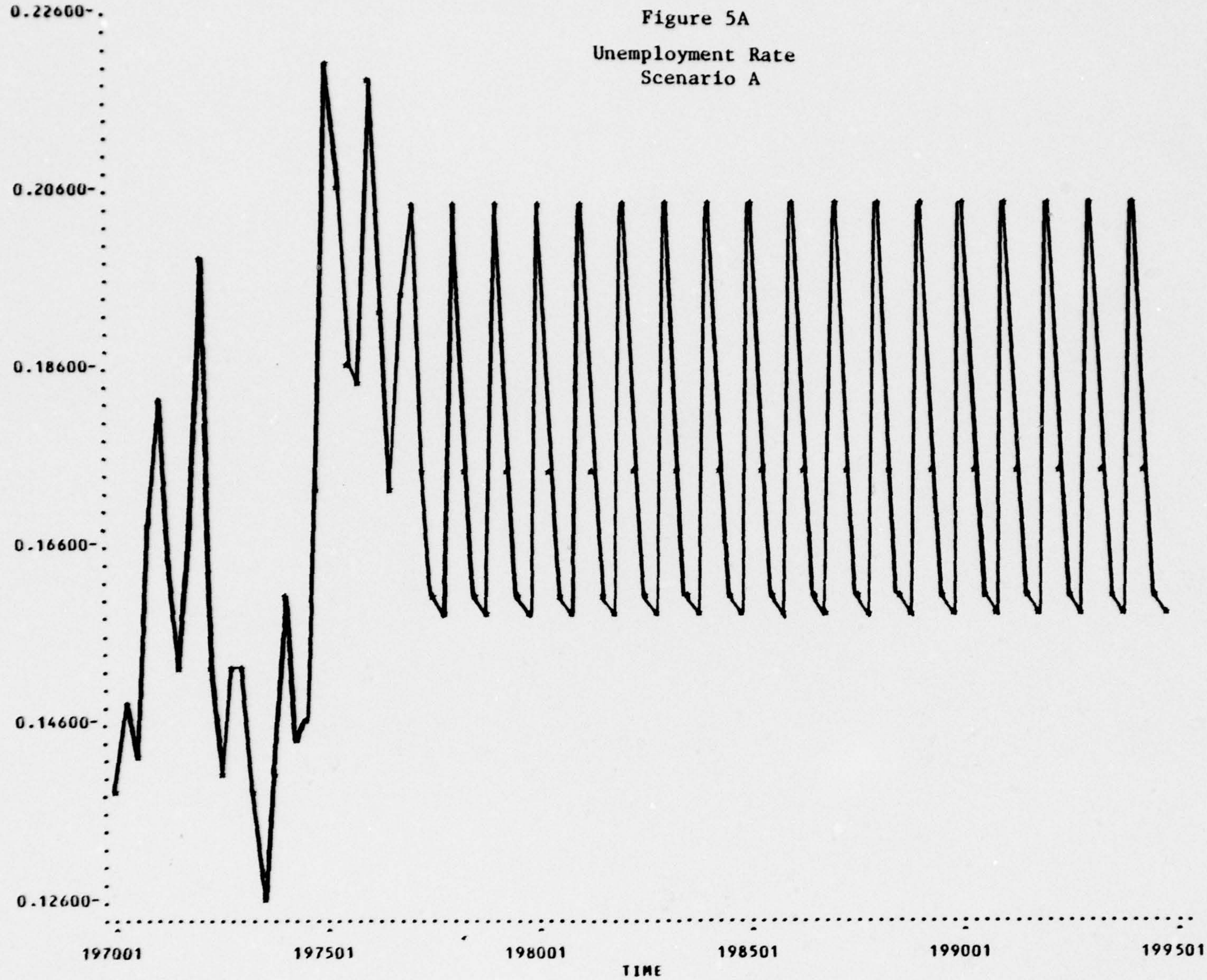
	I-II		III		IV	
	ALL	HSG	ALL	HSG	ALL	HSG
C	10.51	10.76	2.69	9.27	6.48	-5.67
EL	.52	.22	.70	.09	-	-
U(-2)	.46	.54	.94	1.67	-	-
$W^M(-2)$	.39	.47	.23	.17	.09	1.39
$W^C(-1)$	-.94	-.76	-	-	-	-
RS1[b]	-	-	-	-	-	-
RS2[b]	-	-	-	-	-	-
S1	.10	.09	.04	.05	-.26	-.18
S2	-.06	-.06	-.00	.04	.13	.12
S3	.38	.38	.37	.38	.49	.50

a. See Table 1 for definition of variables. Coefficients will differ from those reported in Table 1 because variables with the theoretically incorrect impact are excluded. Also, one independent variable observation was updated between the estimation reported in Table 1 and the coefficients presented in this table.

b. With acceptance probabilities at 100 percent, these coefficient are no longer relevant.

Figure 5A

Unemployment Rate
Scenario A



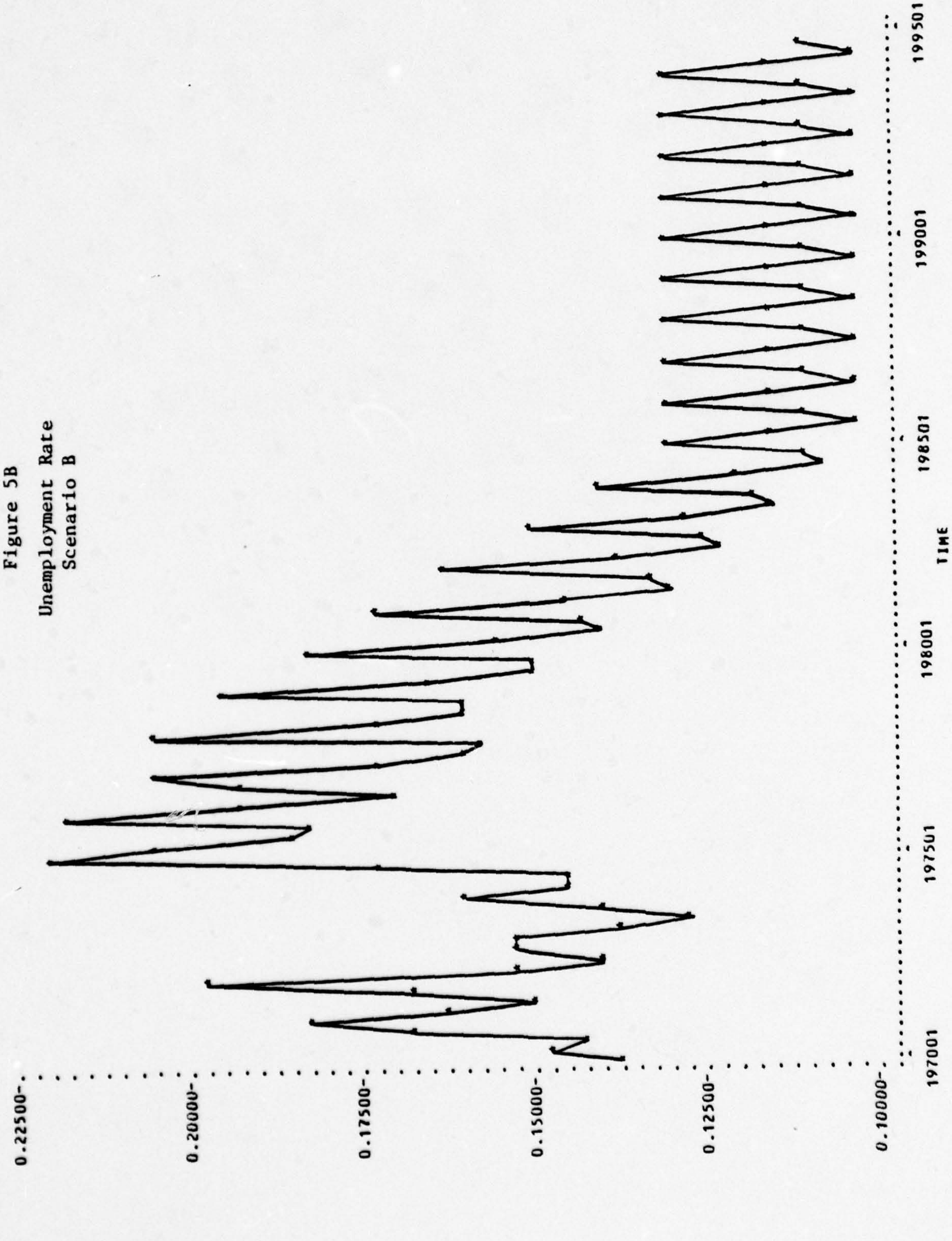
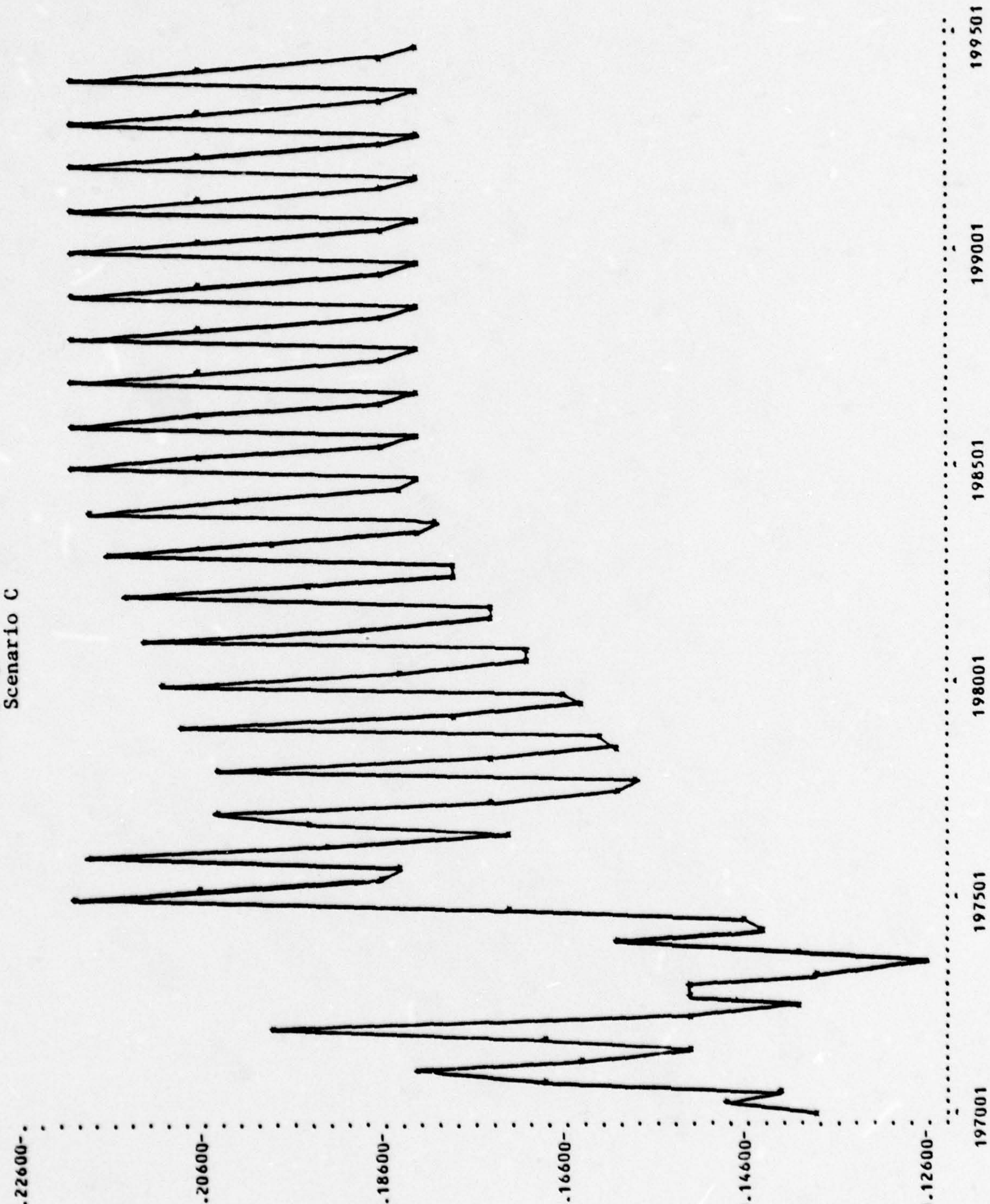


Figure 5B
Unemployment Rate
Scenario B

Figure 5C
Unemployment Rate
Scenario C



The simulation results are reported in Tables 5 and 6. Under a continuation of 1977 unemployment rates (Scenario A), projected enlistments decline gradually from 79 thousand to almost 66 thousand by 1994. The average annual shortfall from 1979 through 1985 is approximately 19,200 with acceptance probabilities at 100 percent, a reduction of 4,000 in the shortfall projected with 1977 acceptance probabilities. On the one hand, if unemployment rates should worsen as depicted in Scenario C, enlistments increase through 1984 and then decline as the effect of increasing unemployment at first exceeds the effect of a decreasing eligible pool. Projected shortfalls would average 14,660 per year from 1979-1985, an improvement of 4,540 over Scenario A. On the other hand, if unemployment rates should improve (Scenario B), enlistments would decline relatively more rapidly through 1985 when unemployment rates (are assumed to) level off, and thereafter decline more gradually. Over the 1979-85 period, projected shortfalls would average 29,100, an increase of almost 9,900 over Scenario A.

Under Scenarios A and C, the share of Cat. I-II & III HSG enlistments are projected to markedly increase. The explanaton is that HSG relative to NHSG enlistments were found to fall more slowly with a decreasing eligible pool and to rise more rapidly with increasing unemployment (see Tables 1 and 4). Accordingly, the quality improvement is most pronounced in Scenario C, where the Cat. I-II & III HSG share moves from 65 to 78 percent, but nevertheless is striking even in Scenario A. Under Scenario B, however, in terms of the impact upon quality composition the improvement in unemployment rates works against the decreasing eligible pool to produce a fall in the share of Cat. I-II & III HSG enlistments through 1985; thereafter, with unemployment rates assumed to level off, the decreasing eligible pool produces the same quality composition improvement as in the other scenarios.

Table 5

Projected Enlistments
(1000's)

FY ending 3rd quarter	Requirements[a]	Projections			Percent of Requirements		
		A.	B.	C.	A.	B.	C.
1979	94.0	78.7	78.2	79.6	83.7	83.2	84.7
1980	101.0	78.6	74.6	80.8	77.8	73.9	80.0
1981	100.0	78.3	71.2	81.8	78.3	71.2	81.8
1982	91.0	77.8	67.5	82.6	85.5	74.2	90.8
1983	96.0	77.0	63.7	82.9	80.2	66.3	85.8
1984	96.0	75.6	59.5	82.4	78.8	62.0	85.8
1985	96.0	74.1	55.7	81.5	77.1	58.0	84.9
1986		72.4	53.6	80.1			
1987		70.9	52.5	78.4			
1988		70.2	52.0	77.6			
1989		70.0	51.9	77.5			
1990		69.9	51.8	77.4			
1991		69.4	51.4	76.8			
1992		68.4	50.6	75.6			
1993		66.8	49.5	73.9			
1994		65.5	48.8	72.4			

[a]Estimated by Congressional Budget Office--see text.

Table 6

Projected Composition
of Enlistments
(percentage)

FY ending 3rd quarter	I-II & III HSG			IV		
	A.	B.	C.	A.	B.	C.
1979	64.9	64.6	65.1	8.9	8.9	8.8
1980	64.9	62.9	65.8	9.0	9.4	8.7
1981	65.1	61.5	66.7	9.0	9.8	8.6
1982	65.3	60.0	67.6	9.1	10.4	8.6
1983	65.8	58.9	68.7	9.2	11.0	8.5
1984	66.6	57.9	70.2	9.4	11.8	8.6
1985	67.6	57.1	71.7	9.6	12.7	8.7
1986	68.7	57.4	73.2	9.8	13.2	8.9
1987	69.7	58.1	74.3	10.1	13.5	9.1
1988	70.2	58.4	74.9	10.2	13.7	9.2
1989	70.3	58.4	75.0	10.2	13.7	9.2
1990	70.3	58.4	75.0	10.3	13.8	9.3
1991	70.6	58.6	75.4	10.4	14.0	9.4
1992	71.4	59.2	76.3	10.5	14.2	9.5
1993	72.5	60.0	77.5	10.8	14.5	9.8
1994	73.4	60.7	78.5	11.0	14.9	10.0

In all three scenarios the share of Cat. IV enlistments increase--gradually under Scenarios A and C to 10-11 percent, and under Scenario B to 15 percent.

In sum, the implication of the differential supply elasticities by groups is that, on the one hand, the impending decrease in the numberr of eligible young men over the next 15 years will more markedly curtail NHSG enlistments, and a possible worsening of unemployment among youth will produce relatively more HSG vis-a-vis NHSG enlistments. On the other hand, an improvement in unemployment rates will not only further exacerbate the projected shortfalls, but also reduce the quality composition of enlistments.

V. SUMMARY AND CONCLUSIONS

Recruit quality has been viewed as the outcome of a process in which Navy recruiters maximize the quality of recruits subject to a quota filling requirement. A statically optimal strategy is to set recruitment standards low when the quota is large relative to the available supply of recruits and to set it high when the quota is small relative to the supply. This strategy produces changes in expected (i.e., average) recruit quality which vary inversely with changes in the quota-to-supply ratio. However, the expected number of recruits may increase or may decrease in response to a change in the supply of applicants and will depend upon the impact of the concomitant change in recruitment standards.

The impact of a number of factors upon applicant supply and hence upon recruit quality was investigated with quarterly enlistment data for male non-prior service accessions, categorized by mental category and education attainment. The strength and significance of the explanatory factors varied by quality group. In general, there was a stronger relationship between eligible pool size and NHSG compared to HSG recruitment, and between youth unemployment rates and HSG compared to NHSG recruitment. Military pay elasticities tended to be lower than those commonly found in forecasts, while estimates of civilian pay elasticities were wide ranging.

In projecting recruitment over the next 15 years, we assumed that there is no major change in military recruitment behavior, that the growth of military pay levels keep pace with civilian earnings, and that projected accessions requirements are adhered to. The simulations of the quality and quantity of Navy recruits reported here indicate quite clearly that recruiting quotas may not be met even if standards are lowered to accept applicants. However, the resulting quality composition does not deteriorate uniformly or under all scenarios. In response to a shrinking eligible pool, NHSG recruitments fall faster than HSG recruitments, tending to improve the quality composition. Moreover, if unemployment remains at 1977 levels or deteriorates to 1974-75 levels, the greater responsiveness of HSG (compared to NHSG) enlistments to rising unemployment produces a rising share of HSG enlistments even as total enlistments decline in response to a falling eligible pool. If unemployment rates improve to 1969-70 levels, the share of HSG enlistments falls, but the decline is mitigated by the greater responsiveness (i.e., decrease) of NHSG (compared to HSG) recruitments to a shrinking pool size. Under both unemployment scenarios, the Cat.IV share is also increasing--a direct reflection of the lowered standards.

The persistence of shortfalls in the face of lowered recruitment standards implies that the Navy will not be able to meet its projected manpower needs by adjusting standards, but must make major changes to increase the total supply of recruits or to cut back accession requirements. The policy options available to increase supply would appear to be more aggressive recruitment, higher levels of compensation, and acceptance of more women into the service. The policy options on the demand side include increasing the reenlistment rate, and the adoption of less labor intensive staffing patterns.

APPENDICES

Table A-1

Enlistment Equation Results
Adaptive Expectation Model[1]

	I-II HSG	I-II NHSG	III HSG	III NHSG	IV HSG	IV NHSG	I-II	III	IV
C	15.64[a]	1.73	-10.04	-15.84	90.17[a]	-12.98	15.83[a]	-8.93	89.93[b]
EL	.24	2.94[b]	(-.25)	1.43	(-1.12)	(-21.2)[c]	.61[a]	.31	(-4.08)[c]
U50	.66[c]	.40	2.27[c]	(-.05)	(-4.98)[c]	2.46	.59[b]	1.34[c]	(-3.89)[c]
$W^M 50$	.53[a]	.19	.12	1.15[a]	4.51[c]	4.30[b]	.40	.41	5.18[c]
$W^c 75$	-1.31	-1.78	(2.46)[b]	(.28)	-12.91[c]	(14.15)	-1.52	(1.46)	-10.68
RS1	-	-.72	.96	-.23	2.61	-4.59	-	.46	2.05
RS2	-	-3.21	.42	-2.49	2.49	-17.32	-	-.77	1.06
S1	.03	.08	-.11	.02	-.14	-.38	.05	-.06	-.22
S2	-.09	-.02	-.12	-.09	.55[a]	.06	-.07	-.11	.47
S3	.43[c]	.33[a]	.47[c]	.32	.77[c]	-.02	.42[c]	.42[c]	.68
R^2(corr.)	.76	.31	.85	.47	.57	.67	.75	.82	.60
D-W	2.05	1.19	1.44	1.90	1.37	.98	2.05	1.82	1.26

Note: Coeffs. significantly greater or less than zero at .10 (a) level, .05 (b) level, .025 (c) level; coeffs. with "wrong" sign are shown in parentheses.

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1. See Table 2 for definition of variables.

The suffix 50 indicates that the coefficient of expectations (β) is 0.50 in the calculation $P_t^* = \sum_{i=o} \beta (1-\beta)^i P_{t-1-i}$; similarly for the 75 suffix.

Table A-2

Enlistment Equation Results
Relative Pay Model[1]

	I-II		III		IV	
	HSG	NHSG	HSG	NHSG	HSG	NHSG
C	7.57[c]	-13.03[a]	11.41[c]	-6.79	20.08[b]	120.73[c]
EL	.28	2.85[c]	.02	1.97[c]	(-2.27)[b]	(-16.15)[c]
U(-2)	.61[c]	.50	1.65[c]	(-.39)	(-3.74)[c]	(-1.21)
$W^{MC}(-1)$	.36	(-.07)	.22	1.01[a]	4.74[c]	3.99[b]
RS1	-	-1.06	.51	-.99	3.18	-6.08
RS2	-	-4.27	-.75	-4.46	3.84	-20.73
S1	.08	.12	.04	-.08	-.65	-.66
S2	-.05	.01	.03	-.18	-.17	-.07
S3	.38[c]	.27	.38[c]	.32[c]	.84[c]	.13
R^2(corr.)	.75	.33	.81	.50	.48	.65
D-W	2.08	1.18	1.25	1.84	1.30	.82

Note: Coeffs. significantly greater or less than zero at .10 (a) level, .05 (b) level, .025 (c) level; coeffs. with "wrong" sign are shown in parentheses.

1. See Table 1 for definition of variables; $W^{MC} = \log[W^M(-1)/W^c(-1)]$.

Table A-3

Enlistment Equation Results
Seasonal Dummies Excluded[1]

	I-II		III		IV	
	HSG	NHSG	HSG	NHSG	HSG	NHSG
C	.24	-10.76	-1.22	-29.38[c]	-16.87	37.93
EL	(-.36)	2.24[b]	(-.46)	.83	(-5.22)[c]	(-18.21)[c]
U(-2)	1.34[c]	.84	2.57[c]	.95[b]	(-.44)	2.16
$W^M(-2)$	.75	.37	.31	.98[a]	6.39[c]	2.85
$W^c(-1)$	(.72)	-.05[a]	(1.61)[a]	(2.52)[b]	(.66)	(8.05)[a]
RS1	-	-1.70	-.37	-1.42	3.95	-5.77
RS2	-	-5.96	-3.14	-5.71	5.59	-20.25
R^2(corr.)	.41	.33	.70	.48	.38	.69
D-W	2.68	1.34	2.05	2.23	1.15	1.16

Note: Coeffs. significantly greater <u>or</u> less than zero at .10 (a) level, .05 (b) level, .025 (c) level; coeffs. with "wrong" sign are shown in parentheses.

1. See Table 1 for definition of variables.

DATA APPENDIX

The variables used in the regressions will be described briefly here. Further information about data and procedures is available upon request from the author.

APPENDIX B

DATA DESCRIPTION

1. Enlistments

The basic source of enlistments are monthly data for male, non-prior service accessions by mental category and high school graduate status, made available by the Defense Manpower Data Center (DMDC). Accessions for a particular month are comprised of immediate entries and those from the delayed entry pool. Inability to distinguish these components is a shortcoming characteristic of all research in the field (see below).

Men entering a reserve program can be identified in the DMDC data and hence excluded from October 1975 onward. Before that coverage is uneven, and identification is not possible. In comparison with annual data known to exclude reservists, we concluded that a non-negligible number of reservists are included in the January 1973 to September 1975 data. Using AFEES quarterly totals as a base, we applied the DMDC mental category and education proportions to derive an adjusted set. For the period July 1970 to December 1972 no adjustments were deemed necessary (to exclude reservists).

A second correction to the data was necessitated because during 1973 and 1974 Navy recruiters were administering the qualifications test and some were aiding the enlistees. Hence, for this period published data overestimate the number of Cat.III's relative to Cat.IV's. Estimates of the true proportions, determined by the Navy in 1975 through re-testing, were used to revise the data.[1] Educational misclassification did not arise.

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1. The true proportion of Cat.III's (of total enlistments) is estimated at 42.4 percent in 1973 and 40.2 percent in 1974, compared to published shares of approximately 58 percent and 61 percent. For Cat.IV's the true proportions are 17 percent and 27 percent, compared to published shares of approximately 3 percent and 5 percent.

With the use of estimates of draft-motivated enlistments made by General Research Corporation for the period when the lottery began (July 1970) to when draft authority expired (June 1973), we adjusted the data to a true volunteer basis.[1] The data are presented in Table B-1.

2. Eligible Pool

Measurement of the number of 17-21 year-old men (civilian, non-institutional) forming the eligible pool were taken from various issues of the U.S. Bureau of the Census P-20 Population Characteristics Series: School Enrollment-Social and Economics Characteristics of Students. The October measure reported was treated as a fourth quarter value, and the remaining quarters are obtained by linear interpolation. The primary eligible pool is comprised of those not enrolled in school. We further distinguish between those who are high school graduates and those who are not (see Table B-2).

3. Unemployment

Monthly, seasonally unadjusted unemployment rates for males in the civilian labor force were obtained from Employment and Earnings, Table A-3, published by the Bureau of Labor Statistics. Series were formed for 16-19, 16-21, and 20-24 year-old groups. From the same source, we also obtained the average (mean) duration of unemployment for 16-21 year-old males. Simple quarterly averages were calculated from the monthly data (see Table B-2).

4. Civilian Earnings

Civilian earnings for young men was estimated with median money income of year-round, full-time (male civilian) workers from issues of the Current

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1. Grissmer, Pearson, Szymanski, Evaluation of the Modern Volunteer Army Program, Vol. II, the RAC All Volunteer Data Base, Research Analysis Corproation, McLean, Virginia, November 1972; Grissmer, Hobson, Pearson, Szymanski, The GRC All Volunteer Data Base, General Research Corproation, McLean, Virginia, December 1973; and unpublished data made available by Mrs. Gerry P. Sica, GRC.

Population Reports P-60 Series, Consumer Income. The March observation is treated as the first quarter value, and the others are obtained by linear interpolation. The median income for those 14-19 and 20-24 years old were multiplied by two and summed. This procedure yields an estimate of the sum of four years' civilian pay under the assumptions that a typical recruit enlists for a four-year term at age 18, and that the averge earnings of 18 and 19 year-olds is approximated by that for 14-19 year-olds, and that for 20 and 21 year-olds by the 20-24 year-old average. Estimates for 1977 II, III, IV are based on a regression of median money income on average weekly earnings of production and non-supervisory personnel in the private, non-agricultural sector. This civilian pay variable is expressed in constant 1958 dollars based on the Consumer Price Index (see Table B-3).

5. Military Pay

The index of military pay selected is the sum of base pay over the four-year enlistment period. Base pay rates were weighted by the distribution of Navy, active duty males by pay grade and years of service to form a measure of an expected (base) pay, for the average enlistee over the period. The quarters and subsistence, and tax advantage components of full compensation are not included because they have changed little in real terms over the period. Accordingly, their inclusion was not deemed worth the extra work. Data for the period 1970-75 was provided by Alan Fechter. For 1976 and 1977, it was updated with Joint Service Pay Tables effective October 1, 1975, 1976, and 1977, and combined with data from "Active Duty Enlisted Personnel by Length of Service and Sex Spreading Paygrade Within Branch and Class" as of June 30, 1975 and 1976, and September 30, 1977 (MAPMIS 5314-4100) (see Table B-3).

Table B-1a

Total and Cat.I-II Enlistments

	V	V12	V12HS	V12NHS
197003	15702.0	6737.02	5422.51	1314.51
197004	9767.29	4294.69	3958.70	335.985
197101	15747.8	5991.38	5211.72	779.666
197102	11612.6	4269.65	3837.03	432.623
197103	22334.5	8403.43	7829.48	573.954
197104	14787.4	5820.71	5395.74	424.965
197201	16499.0	5966.41	5502.12	464.290
197202	20162.4	5291.80	4597.71	694.094
197203	34931.4	10335.4	9114.85	1220.51
197204	17180.6	6225.78	5344.59	881.196
197301	12588.0	5803.34	5108.65	694.685
197302	16120.5	6234.58	5459.63	774.953
197303	25007.0	9077.99	8200.21	877.772
197304	12157.2	4553.22	3938.29	614.934
197401	17314.1	6326.11	5213.27	1112.84
197402	17928.0	6047.99	5040.41	1007.58
197403	26828.4	9030.40	7910.53	1119.87
197404	20286.8	6681.77	5627.89	1053.88
197501	12911.0	6116.53	5398.94	717.586
197502	17362.0	7158.89	6422.02	736.873
197503	22166.0	8943.90	8145.94	797.963
197504	18290.0	7790.00	6531.00	1259.00
197601	16739.0	7870.00	5929.00	1941.00
197602	17331.0	8690.00	6350.00	2340.00
197603	27152.0	13278.0	11136.0	2142.00
197604	19670.0	9123.00	7553.00	1570.00
197701	17543.0	7538.00	6215.00	1323.00
197702	15945.0	6247.00	5337.00	910.000
197703	28563.0	10513.0	8796.00	1717.00
197704	13126.0	5417.00	4289.00	1128.00

Table B-1b

Cat.III Enlistments

	V3	V3HS	V3NHS
197003	6933.14	4513.50	2419.65
197004	4056.97	3071.13	985.847
197101	6730.25	4272.65	2457.60
197102	4843.58	3378.64	1464.95
197103	10185.2	8182.37	2002.84
197104	6330.87	4715.94	1614.93
197201	7293.38	5263.28	2030.11
197202	8457.76	5455.23	3002.53
197203	14900.9	9805.85	5095.06
197204	8250.49	4918.56	3331.93
197301	4885.31	2853.03	2032.28
197302	7058.86	4362.68	2696.18
197303	11357.0	7053.00	4304.00
197304	5422.00	2722.00	2700.00
197401	6571.00	2970.00	3601.00
197402	7104.00	3680.00	3424.00
197403	10643.0	5598.00	5045.00
197404	8136.00	3653.00	4483.00
197501	6500.30	4441.10	2059.19
197502	9286.73	7258.07	2028.65
197503	11962.9	9597.67	2365.21
197504	9660.00	6478.00	3182.00
197601	8237.00	4293.00	3944.00
197602	7903.00	5001.00	2902.00
197603	12997.0	9266.00	3731.00
197604	10046.0	6278.00	3768.00
197701	9621.00	5936.00	3685.00
197702	9228.00	6551.00	2677.00
197703	17236.0	11526.0	5710.00
197704	7409.00	4990.00	2419.00

Table B-1c

Cat.IV Enlistments

	V4	V4HS	V4NHS
197003	2031.80	990.752	1041.04
197004	1415.63	736.881	678.750
197101	3026.14	1362.92	1663.22
197102	2499.39	1478.75	1020.64
197103	3745.86	2694.74	1051.12
197104	2635.82	1714.59	921.233
197201	3239.25	1774.48	1464.77
197202	6412.80	2406.69	4006.12
197203	9695.10	4251.94	5443.16
197204	2704.35	1389.43	1314.93
197301	1899.34	1532.63	366.713
197302	2827.04	2334.65	492.395
197303	4572.00	4220.00	352.000
197304	2182.00	1986.00	196.000
197401	4417.00	4201.00	216.000
197402	4776.00	4609.00	167.000
197403	7155.00	6990.00	165.000
197404	5469.00	5338.00	131.000
197501	294.171	287.034	7.13622
197502	916.378	886.870	29.5077
197503	1259.21	1236.27	22.9394
197504	840.000	788.000	52.0000
197601	632.000	584.000	48.0000
197602	738.000	625.000	113.000
197603	877.000	856.000	21.0000
197604	501.000	489.000	12.0000
197701	384.000	350.000	34.0000
197702	470.000	429.000	41.0000
197703	814.000	733.000	81.0000
197704	300.000	282.000	18.0000

Table B-2

Eligible Pool (1000's) and Unemployment Rate

	All Male	HSG	NHSG	16-19 Unemployment Rate
197003	3169.78	2044.67	1125.11	0.142127
197004	3281.40	2139.00	1142.40	0.167845
197101	3349.65	2186.07	1163.58	0.182961
197102	3417.92	2233.15	1184.77	0.163181
197103	3486.18	2280.22	1205.96	0.151148
197104	3554.50	2327.30	1227.20	0.168155
197201	3688.45	2431.90	1256.55	0.197472
197202	3822.40	2536.50	1285.90	0.151719
197203	3956.35	2641.10	1315.25	0.139773
197204	4090.30	2745.70	1344.60	0.151885
197301	4178.44	2380.02	1348.42	0.151625
197302	4266.60	2914.35	1352.25	0.138449
197303	4354.74	2998.67	1356.07	0.126997
197304	4443.00	3083.00	1360.00	0.139615
197401	4510.42	3111.42	1399.00	0.159153
197402	4577.95	3139.85	1438.10	0.144738
197403	4645.47	3168.27	1477.20	0.145979
197404	4713.00	3196.70	1516.30	0.172439
197501	4687.57	3196.25	1491.32	0.220863
197502	4662.15	3195.80	1466.35	0.205149
197503	4636.72	3195.35	1441.37	0.186061
197504	4611.30	3194.90	1416.40	0.183000
197601	4666.78	3221.82	1444.96	0.216000
197602	4722.27	3248.75	1473.52	0.192000
197603	4777.75	3275.67	1502.08	0.171000
197604	4833.20	3302.60	1530.60	0.193000
197701	4840.01	3296.85	1543.16	0.204000
197702	4346.82	3291.10	1555.72	0.173000
197703	4853.63	3285.35	1568.28	0.159000
197704	4860.50	3279.60	1580.90	0.156000

Table B-3

Civilian Earnings and Military Pay

	Civilian Pay		Military Base Pay	
		(1958 dollars)		(1958 dollars)
197003	20948.0	15402.9	10946.9	8049.21
197004	20817.0	15106.7	10926.0	7928.88
197101	20686.0	14892.7	11765.8	8470.70
197102	21136.5	15054.5	11743.3	8364.20
197103	21587.0	15212.8	11707.8	8250.71
197104	22037.5	15454.1	14336.0	10053.3
197201	22488.0	15649.3	16775.3	11673.8
197202	22995.0	15869.6	16735.5	11549.7
197203	23502.0	16075.2	16703.9	11425.4
197204	24009.0	16277.3	16688.6	11314.3
197301	24516.0	16387.7	17788.9	11890.9
197302	25049.0	16382.6	17772.8	11623.8
197303	25582.0	16357.2	17757.1	11360.9
197304	26115.0	16332.1	18833.4	11778.2
197401	26645.0	16209.2	18817.3	11446.0
197402	27075.0	16011.2	18801.2	11118.4
197403	27502.0	15757.5	18789.2	10786.0
197404	27929.0	15576.7	19825.7	11057.2
197501	28356.0	15523.4	19825.7	10853.5
197502	28550.0	15393.7	19825.7	10689.6
197503	28744.0	15168.3	19969.9	10538.2
197504	28938.0	15035.4	19969.9	10375.8
197601	29132.0	15186.4	19969.0	10409.7
197602	30233.5	15565.0	19947.0	10269.3
197603	31335.0	15878.7	19947.0	10107.9
197604	32436.5	16257.3	20668.0	10358.9
197701	33538.0	16514.7	20668.0	10177.3
197702	33932.5	16357.7	20668.0	9963.36
197703	34327.0	16312.8	20610.0	9794.23
197704	34721.5	16322.6	21872.0	10282.1

APPENDIX C

It was asserted without proof in the text that the expected value of recruit quality was positively related to the recruit acceptance standard q_o. The proof is as follows:

$$\text{Let } P(q_o) = \int_{q_o}^{\infty} f(q)\,dq \qquad \text{(A1)}$$

$$\text{then } E(q|q>q_o) = \frac{\int_{q_o}^{\infty} qf(q)\,dq}{P(q_o)} \qquad \text{(A2)}$$

$$\text{and } \frac{dE(q|q>q_o)}{dq_o} = \frac{-P(q_o)q_o f(q_o) - \left[\int_{q_o}^{\infty} qf(q)\,dq\right] f(q_o)}{[P(q_o)]^2} \qquad \text{(A3)}$$

$$= \frac{f(q_o)}{P(q_o)} \left[E(q|q>q_o) - q_o\right] > 0 \qquad \text{(A4)}$$

It was also asserted that under certain conditions the marginal impact of aggregate supply on the number of recruits with given characteristics ($\underline{x}^*$) was monotonic in the level of a particular characteristic (x_i) under these sufficient conditions:

1. The distribution of the aggregate supply of recruits across characteristics is constant. This assumption implies that

$$\frac{\partial s(\underline{x}^*)}{\partial S} = \frac{s(\underline{x}^*)}{S} \qquad \text{(A5)}$$

The elasticity (ε) may be written as

$$\varepsilon = \frac{S}{E(R|\underline{x}^*)} \frac{\partial E(R|\underline{x}^*)}{\partial S} = \frac{S}{P(q_o|\underline{x}^*)\ s(\underline{x}^*)} \frac{\partial E(R|\underline{x}^*)}{\partial S} \qquad \text{(A6)}$$

$$\text{where } P(q_o|\underline{x}^*) = \int_{q_o}^{\infty} f(q|\underline{x}^*)\,dq$$

Substituting (14) from the text and (A5) into (A6) gives

$$\varepsilon = 1 - \frac{f(q_o|\underline{x}^*)}{P(q_o|\underline{x}^*)} \frac{P(q_o)}{f(q_o)} \tag{A7}$$

where $P(q_o) = \int_{q_o}^{\infty} f(q)dq$

The elasticity is montonic in x_i if the derivative $\frac{d\varepsilon}{dx_i}$ is strictly positive or negative. The derivative may be written as:

$$\frac{d\varepsilon}{dx_i} = - \frac{P(q_o)}{f(q_o)} \frac{\left[P(q_o|\underline{x}^*) \frac{\partial f(q_o|\underline{x}^*)}{\partial x_i} - f(q_o|\underline{x}^*) \frac{\partial P(q_o|\underline{x}^*)}{\partial x_i}\right]}{[P(q_o|\underline{x}^*)]^2} \tag{A8}$$

It follows that

$$\frac{d\varepsilon}{dx_i} \begin{matrix} > \\ = \\ < \end{matrix} 0 \text{ as } \frac{\partial P(q_o|\underline{x}^*)}{\partial x_i} \begin{matrix} < \\ = \\ > \end{matrix} \frac{P(q_o|\underline{x}^*) \frac{\partial f}{\partial x_i}(q_o|\underline{x}^*)}{f(q_o|\underline{x}^*)} \tag{A9}$$

Equation (A9) implies the second sufficient condition:

2. If $P(q_o|\underline{x}^*)$, the acceptance probability for an applicant with characteristics $\underline{x}^*$, is strongly monotonic in x_i, the elasticity ε will be monotonic in the same direction.

For example, if test score were strongly and positively correlated with quality, one would expect the (signed) elasticity of recruits with respect to aggregate supply to increase with test score level.

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