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DOCUMENTATION FOR THE RECRUITING COST ESTIMATES
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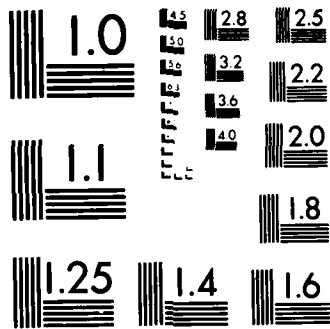
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PROFESSIONAL PAPER 390 / September 1982

DOCUMENTATION FOR THE RECRUITING COST ESTIMATES UTILIZED IN THE NAVY COMPREHENSIVE COMPENSATION AND SUPPLY STUDY

Deborah Clay-Mendez

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DOCUMENTATION FOR THE RECRUITING COST ESTIMATES UTILIZED IN THE NAVY COMPREHENSIVE COMPENSATION AND SUPPLY STUDY

Deborah Clay-Mendez



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DOCUMENTATION FOR THE RECRUITING COST ESTIMATES
UTILIZED IN THE NAVY COMPREHENSIVE COMPENSATION AND SUPPLY STUDY

INTRODUCTION

The cost function for Navy recruiting utilized in the Navy Comprehensive Compensation and Supply Study (NACCS) is based on the recruiting cost function for high school graduates, reported in [1]. Outlined below are the modifications we introduced into this cost function to apply it in the NACCS model. — to p. 3

THE EXCLUSION OF NON-DIPLOMA GRADUATES

The Navy recruiting supply and recruiting cost functions described in [1] pertain to all non-prior service male recruits* who are high school graduates (HSGs). These include both high school diploma graduates (HSDGs) and non-diploma graduates (GEDs). Because the NACCS model distinguishes between diploma and non-diploma graduates, we had to modify the recruiting cost function to exclude the non-diploma graduates. We did this by assuming that the resources necessary to recruit 107 high school graduates (HSDGs and GEDs) would attract 100 HSDGs. As shown in table 1, DMDC data on Navy recruit contracts

* Throughout this paper, the term "recruits" refers to non-prior service male Navy recruits unless specified otherwise.

indicate that over fiscal years 1977, 1978 and 1979 approximately seven percent of the HSG recruits were non-diploma graduates.*

TABLE 1

NAVY NON-PRIOR SERVICE MALE CONTRACTS:
NON-DIPLOMA GRADUATES AS PERCENT OF TOTAL GRADUATES^a

	<u>FY 1977</u>	<u>FY 1978</u>	<u>FY 1979</u>	<u>FY 1980</u>
All Mental Categories	.06	.08	.08	.10
Mental Categories 1-3 Upper:	.06	.09	.10	.12
Mental Categories 3 Lower-4	.06	.05	.05	.06

^a Data supplied by DMDC.

Incorporating this into the cost function reported on p. 8 of [1], we obtain the following:

$$\text{Minimum Recruiting Cost} = 2426.5 \times e^{\left(\frac{\text{HSDG} \times 1.07 + 309599.7}{34894.2}\right)}$$

While a more exact estimate of recruiting costs for diploma graduates might obtained by direct derivation from a recruit supply equation for HSDGs, a comparison reveals little difference between the HSG recruit

* The recruit supply equations on which our cost function is based were estimated using data for these three years. See [1].

supply equation from which our original cost function is derived and a recruit supply function estimated solely for HSDGs.*

THE EXCLUSION OF RECRUITS WITH OTHER THAN A FOUR-YEAR SERVICE OBLIGATION

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The NACCS model is designed to simulate the costs associated with varying the flows of non-prior service males with four-year service obligations. The flows of recruits with three, five, or six-year obligations are not dealt with directly. Yet as the costs of recruiting an additional HSDG for a four-year service obligation depends on the total number of HSDGs recruited, the NACCS cost function must take into account the recruiting requirements for HSDGs with these other service obligations. In calculating recruiting costs for HSDGs with four-year obligations, we assumed that an additional 24,100 HSDGs were needed to fill these requirements. (In FY 1979, this was the actual number of non-prior service male recruits with high school diplomas and service obligations of three, five, or six years.) Given these requirements, the minimum cost of recruiting X number of HSDGs for four-year obligations is the cost of recruiting X + 24,100 HSDGs less the cost of recruiting 24,100 HSDGs.**

* See appendix A, tables A-1 and A-2.

** This involves the implicit assumption that the cost of recruiting a given total number of HSDG recruits with the prevailing mental group distribution will not be affected by the level of requirements for HSDG recruits with service obligations of other than four years.

The recruiting cost function for HSDGs with four-year obligations which results is:

$$\text{Minimum Recruiting Cost} = 2426.5xe \frac{(x+24100)x1.07+309599.7}{34894.2}$$

$$- 2426.5 x e \frac{24100x1.07+309599.7}{34894.2} =$$

$$2426.5xe \left[\frac{x}{32611.4} + 9.611 \right] - 36.24x10^6$$

With the addition of AFEES testing costs, this is the recruiting cost function utilized in the NACCS study for HSDGs. It can easily be recalculated if alternative assumptions are made about the number of HSDG recruits needed for service obligations of other than four years.

Specification of the Mix of HSDG Recruits by Upper and Lower Mental Categories

Conceptually, the cost of recruiting HSDGs should depend both on the number of recruits obtained and on their distribution by mental categories. Unfortunately, it is not possible to identify empirically the degree to which recruiting costs vary as the mix of recruits is changed.* When separate recruit supply equations were estimated for recruits on the upper and lower mental categories, we found that an additional Navy recruiter increased the number of upper mental group

* Two unsuccessful efforts to obtain such a function are documented in appendix B.

recruits more than it did the number of lower mental group recruits. As a result, when we derived a minimum recruiting cost function from these supply equations, we found that recruits the marginal cost for a recruit in the upper mental categories is less than that for a recruit from the lower mental categories. The problem with these estimates, one might argue, is that recruiters allocate their effort in accordance with Navy policy that they recruit a high proportion (currently 60 percent) of upper mental group individuals. To obtain unbiased estimates, the recruit supply equations should be estimated using the unobservable variable "recruiter effort."

The argument made above implies that, even in a recruit supply equation estimated for all HSGs, the magnitude of the coefficient on recruiters depends on prevailing Navy policies with respect to the mental group mix. Fortunately, the cost function in [1] is developed from an HSG recruit supply function estimated with data from fiscal years 1977, 1978 and 1979. The mix of upper to lower mental group recruits was relatively stable during this period. As a result, we can interpret our cost function as one which specifies the minimum cost of obtaining different numbers of HSG recruits given this historical quality mix. Of each 100 HSDGs recruited, we will assume that 54 percent are in the upper mental group and 46 percent in the lower mental group.*

*The mental group distribution for 1979 is used as our cost function is estimated for that year (i.e., it is based on the economic conditions prevailing in 1979). Use of a weighted mean for the period 1977-79 for the recruit distribution has a negligible impact on our cost estimates.

TABLE 2

NAVY NON-PRIOR SERVICE MALE RECRUIT CONTRACTS:
HSG AND HSDG UPPER MENTAL GROUP CONTRACTS AS A PERCENT OF
TOTAL HSG AND HSDG CONTRACTS^a

	<u>FY 1977</u>	<u>FY 1978</u>	<u>FY 1979</u>	<u>FY 1980</u>
HSG 1-3 Upper	.58	.59	.55	.59
HSDG 1-3 Upper	.58	.58	.54	.56

^a Data supplied by DMDC.

The mental group mix of HSDG recruits with obligations of other than four years is somewhat different from the mix for HSDG recruits as a whole: 16,700 of the 24,100 recruits in 1979 with these other obligations were in the upper mental group, while approximately 7,400 were in the lower mental group. Holding this distribution fixed, we can determine what proportion of HSDGs with four-year obligations will be in the upper and lower mental groups.* Where X is the total number of HSDGs with four-year service obligations, we have the following:

Number of HSDGs with
Four-Year Obligations
in Mental categories 1-3U = $.54 (X+24,100) - 16,700 = .54X - 3686$

* This involves the implicit assumption that the cost of recruiting a given total number of HSDG recruits with the prevailing mental group distribution will not be affected by the level of requirements for HSDG recruits with service obligations of other than four years.

Number of HSDGs with
Four-Year Obligations
in Mental Categories 3L-5 = $.46 (X+24,100)-7,400 = .46X + 3686$

This is the mix of HSDG recruits by upper and lower mental groups which corresponds to the minimum recruiting cost function used in the NACCS study.

The Inclusion of AFEEs Processing Costs for HSDG and Non-HSDG Recruits

The number of non-HSDG recruits is believed to be limited by Navy policy rather than by the available supply. In this sense, the marginal cost to the Navy of attracting a non-HSDG recruit is zero. There are, however, processing costs the Navy incurs as the non-HSDG applicants are interviewed, screened, and tested. These costs may actually be greater for the non-HSDG recruits than they are for the HSDG recruits. One processing cost we were able to identify is the cost of AFEEs processing. It averaged \$250 for non-HSDG recruits and \$90 for HSDG recruits.*

The term $\$90 \times \text{HSDG}$ can be added to the cost function shown above to give the recruiting cost function for non-prior service males with high school diplomas and four-year obligations. For the non-prior service males with four-year obligations who do not have high school

* The calculation of these average costs is described in appendix C. We assume that these processing costs are proportional to the number of recruits, so that average and marginal costs are equal.

diplomas, we assume that \$250 x NHSDG yields a lower bound for recruiting costs. We will have to perform a sensitivity analysis to determine how higher recruiting costs for non-HSDGs would affect the findings of the NACCS study. This is essential because our cost function charges the entire cost of recruiters' salaries and of the salaries of recruiter support personnel to the HSDG recruits. No measure of the time spent by these personnel in processing non-HSDG applicants is available.

REFERENCES

- [1] Memorandum, (CNA)82-0079, "A Minimum Recruiting Cost Function for Male High School Graduates," by Debbie Clay-Mendez, 19 Jan 1982, Unclassified
- [2] CNA, Memorandum 81-0601, "Navy Enlisted Supply Study (Briefing to Navy Recruiting Command), by Lawrence Goldberg, Unclassified, Apr 1981
- [3] OASD(MRA&L)(MPP)(AP), "Fact Sheet: Preliminary Findings from the Study to Profile the Aptitudes of the Current Youth Population," by Dr. W.S. Stillman

APPENDIX A

A COMPARISON OF HSG AND HSDG RECRUIT SUPPLY EQUATIONS

TABLE A-1

NON-PRIOR SERVICE MALE SUPPLY EQUATION ESTIMATED FOR
HSGs AND HSDGs

Variable ^b	Dependent Variable: ^a HSG/POP		Dependent Variable HSDG/POP	
	Coefficient	t(121)	Coefficient	t(121)
ln(R/POP)	2.96	5.51	2.69	5.62
ln(PAYRATIO)	-4.87	-5.55	-5.20	-6.64
ln(AIRFR/POP)	1.82	3.21	1.96	3.87
ln(cc/POP)	-.72	-2.93	-.68	-3.07
ln(CY/POP)	-.37	-.83	-.30	-.76
ln UNEMP	2.36	6.89	2.13	6.98
ln(L/POP)	.97	3.45	1.09	4.33
CONSTANT	4.39	1.68	3.98	1.71
R ²	.71		.75	
S.E.E.	.91		.80	

^aThis represents a preliminary model of HSG recruit supply which was developed and estimated by Larry Goldberg at CNA for the NESS Study. See [2].

^bSee table A-2 for definitions of these variables.

TABLE A-2

DEFINITION OF VARIABLES

<u>Variable</u>	<u>Definition</u>
(by Navy Recruiting Districts and Year)	
HSG	The number of NPS male HSG Navy contracts
POP	Male population aged 17-21, in thousands
R	Navy recruiters, in man-months
PAYRATIO	Average full-time earnings of 18 year old civilian males divided by first year's regular military compensation
AIRFR	The number of Air Force recruiters (in man years)
CC	Expenditures on ETA countercyclical programs
CY	Expenditures on ETA youth programs
UNEMP	Civilian unemployment rate
L	Advertising leads; contacts with potential recruits obtained through advertising
TVR	Expenditures on television and radio advertising
AD	Expenditures on magazine, billboard, and direct mail advertising
HSG1-3U	The number of NPS male HSG Navy contracts for recruits in the upper mental categories
HSG3L-4	The number of NPS male HSG Navy contracts for recruits in the lower mental categories

The similarity in the two equations shown in table A-1 is due largely to the fact that GEDs comprise only 7 percent of the sample; it

is not necessarily evidence of any underlying similarity in the recruit supply functions for GEDs and HSDGs. In a separate supply function which was estimated solely for GEDs, only unemployment had a significant coefficient. In addition, table A-1 indicates that the exclusion of GEDs from the HSG recruit supply function increases the percent of the variation in the dependent variable explained by the model.

APPENDIX B

ESTIMATING RECRUITING COSTS AS A FUNCTION OF NUMBER OF RECRUITS AND MENTAL GROUP DISTRIBUTION

We made two attempts, based on alternative recruit supply models, to estimate minimum recruiting costs of male non-prior service HSG recruits as a function of both the quality and the number of the recruits. Neither attempt yields credible estimates for the marginal costs of recruiting upper vs. lower mental group individuals. We believe that this difficulty arises because we were unable to identify the allocation of recruiter effort between these groups.

Our first effort derives from a preliminary model of Navy recruit supply and a data base which were developed by of CNA for the Navy Enlisted Supply Study. Using pooled cross-section time series data, we estimated separate supply equations for HSG recruits in the upper (1-3 Upper) and lower (3 Lower-4) mental categories. The explanatory variables in each equation include number of recruiters, the military to civilian pay ratio, the unemployment rate, ETA expenditures, and a measure of youth response to Navy advertising (advertising leads). A third equation to predict advertisings leads was then estimated with both economic conditions and the levels of Navy advertising as explanatory variables. This equation was substituted for advertising leads in the first two equations to yield reduced form recruit supply

functions which include advertising levels as an argument.* Table B-1 indicates the functional forms utilized and the values obtained for the various coefficients. The variables used are defined in appendix A, table A-2.

The supply equations shown in table B-1 predict HSG recruit contracts by Navy Recruiting District and year. If we hold constant the economic and demographic variables not controlled by the Navy, the aggregate number of contracts obtained in any year is a function of 88 variables: the level of recruiters in each of the 43 districts, the level of printed media advertising in each district, and the level of military pay and of national advertising. Fortunately, it proves possible to derive a minimum recruiting cost function for each year from an aggregate supply function based on only three variables: the aggregate number of recruiters, aggregate expenditures on printed media advertising, and the level of national advertising. This is because — given the functional form of the supply equations and given price estimates for recruiters and advertising which do not vary across districts — equality in the ratio of prices to marginal products implies that the ratio of recruiters to population and the ratio of advertising to population do not vary across districts. This latter equality allows us to multiply each side of the supply equations by

* The model, as applied to the estimation of a single supply equation for male, non-prior service HSGs, is described in greater detail in [1].

TABLE B-1

PRELIMINARY SUPPLY MODELS FOR
NPS MALE HSG I-IIIU AND HSG IIII-IV CONTRACTS

Dependent Variable	<u>Equation 1a</u>	<u>Equation 1b</u>	<u>Equation 2a</u>	<u>Equation 2b</u>
	<u>ln(HSG 1-3U/POP)</u> Coefficient ($\tau(121)$)	<u>Obtained by Substituting for ln(L/POP)</u> <u>ln(HSG 1-3U/POP)</u>	<u>ln(HSG 3L-4/POP)</u> Coefficient ($\tau(121)$)	<u>Obtained by Substituting for ln(L/POP)</u> <u>ln(HSG 3L-4/POP)</u>
ln(R/POP)	1.71 (4.84)	1.71	1.25 (2.86)	1.25
ln(PAYRATIO)	-3.20 (-5.53)	-3.85	-1.68 (-2.35)	-2.30
ln(AIRFR/POP)	2.10 (5.61)	2.10	-.27 (-.59)	-.27
ln(CC/POP)	.01 (.09)	.06	-.74 (-3.68)	-.70
ln(CY/POP)	-.70 (-2.37)	-.57	.32 (.89)	.45
ln UNEMP	1.14 (5.05)	1.28	1.22 (4.39)	1.35
ln(L/POP)	.50 (2.73)		.47 (2.04)	
ln(TVR/POP)		.12		.12
ln(AD/POP)		.05		.05
CONSTANT	4.94 (2.88)	3.96	-.55 (-1.25)	-1.48
R ²	.70		.38	
SEE	.60		.74	
Mean of dependent variable	3.57		2.47	

The cost function takes on this special form because the proportions of the three inputs (R_T , AD_T , TVR_T) which minimize the cost of obtaining upper mental group recruits are similar to the proportions which minimize the cost of obtaining lower mental group recruits. This is reflected in table B-2 where the total cost associated with a given number of recruits in a mental group is approximately the same regardless of which group resources are allocated to obtain at minimum cost.

TABLE B-2

HSG 1-3U Recruits Obtained at Minimum Costs ^a			HSG 3L-4 Recruits Obtained at Minimum Costs		
(a)	(b)	(c)	(d)	(e)	(f)
# HSG 1-3U	# HSG 3L-4	Cost (\$ Millions)	# HSG 3L-4	# HSG 1-3U	Cost (\$ Millions)
20,000	14,554	45.2	14,554	19,812	45.0
25,000	18,333	58.1	18,333	24,811	57.9
30,000	22,113	74.7	22,113	29,811	74.4
35,000	25,893	96.0	25,893	34,812	95.6
40,000	29,673	123.4	29,673	39,812	122.8
45,000	33,453	158.6	33,453	44,812	157.8
50,000	37,233	203.8	37,233	49,812	202.8
55,000	41,013	262.9	41,013	54,812	260.7

^aThe cost figures in column c are derived by minimizing the total cost of recruiting resources (R_T , AD_T , TVR_T) subject to the constraint described by equation 1 above. The number of recruits in column b is the additional number of HSG 3L-4 recruits forthcoming (at no cost) given the recruiting resources necessary to obtain the HSG 1-3U recruits at minimum cost.

In a second effort to derive a recruiting cost function, we used a revised model of recruit supply which includes expenditures on direct

mail advertising as an explanatory variable. Focus on direct mail as an advertising variable was prompted by the discovery that, when considered separately, expenditures on direct mail have a large and significant impact on advertising leads. This impact was obscured in the previous model where direct mail expenditures were included with expenditures on magazine advertising in the variable "AD" (compare equations 1 and 3 in table B-3). None of the other types of advertising appears with a significant coefficient when considered independently.*

Direct mail advertising is included directly in the supply equation because it might have a greater impact on advertising leads — and ultimately on recruit supply — for one or another of the two mental groups. In the absence of separate data on advertising leads for the two groups, this impact would be obscured under the indirect estimation approach which uses a leads equation.

Table B-4 shows the recruit supply equations for HSG 1-3U and HSG 3L-4 which result from this revised model. The direct mail variable enters strongly into the equation for HSGs in the upper mental groups, while in the equation for HSG contracts in the lower mental groups the

* Although expenditures on television and radio advertising appear with a significant negative coefficient if included directly as a variable in the equation for HSG 3L-4. Use of annual dummy variables reduced the absolute value of this coefficient but did not eliminate its significance. It may be that $\ln(\text{TVR}/\text{POP})$ is correlated with some variable which is omitted from this equation but which does affect the number of HSG 3L-4 recruits. $\ln(\text{TVR}/\text{POP})$ did not appear significant if included in the equation for HSG 1-3U.

TABLE B-3

ADVERTISING LEADS AS A FUNCTION
OF ALTERNATIVE MEASURES OF ADVERTISING

Explanatory Variables	Dependent Variable: $\ln(L/POP)$		
	Equation 1 Coefficient t(121)	Equation 2 Coefficient t(120)	Equation 3 Coefficient t(123)
Constant	-1.97 (-2.82)	-1.68 (-2.95)	-1.92 (-4.20)
$\ln(PAYRATIO)$	-1.31 (-5.02)	-.68 (-2.97)	-.74 (-3.55)
$\ln(CC/POP)$	.09 (1.15)	.43 (5.49)	.43 (6.44)
$\ln(CY/POP)$	.27 (1.91)	.10 (.88)	.09 (.81)
$\ln UNEMP$	.28 (2.43)	.03 (.32)	-- --
$\ln(TVR/POP)$	.25 (2.16)	-.07 (-.65)	-- --
$\ln(AD/POP)$	.10 (2.64)	-- --	-- --
$\ln(MAG/POP)$	-- --	-.01 (-.20)	-- --
$\ln(DM/POP)$	-- --	.30 (7.80)	.30 (8.73)
$\ln(BLK)$	-- --	.12 (4.61)	.12 (4.71)
R ²	.43	.63	.63
SEE	.28	.23	.22
Mean of dependent variable	2.51	2.51	2.51

In the above equations, TVR refers to expenditure on national television and radio advertising. AD refers to all other advertising expenditures. DM refers to direct mail plus outdoor advertising and MAG refers to expenditures on magazine advertising. (The mean level of outdoor advertising was only \$4,476 per district per year; alternative treatment of this variable has little impact.) BLK is the percent of the population that is black. The remaining variables are as defined in appendix A, table A-2.

TABLE B-4

MODIFIED SUPPLY MODELS FOR
HSGs, HSG I-IIIU, AND HSG IIIL-IV RECRUITS

(Navy Contracts for NPS Males)

Explanatory Variables	a	b	c
	HSG/POP	HSG I-IIIU/POP	HSG IIIL-IV/POP
	Coefficient (t(120))	Coefficient (t(120))	Coefficient (t(120))
ln(UNEMP)	2.19 (6.43)	1.22 (5.33)	.87 (4.83)
ln(AIRFR/POP)	2.63 (4.45)	1.89 (4.73)	.73 (2.19)
ln(PAYRATIO)	-4.97 (-6.11)	-2.73 (-4.96)	-2.31 (-5.17)
ln(CC/POP)	-.21 (-.75)	.01 (.03)	-.17 (-1.25)
ln(CY/POP)	-.60 (-1.37)	-.55 (-1.85)	-.08 (-.34)
ln(R/POP)	2.14 (4.14)	1.15 (3.29)	1.01 (3.47)
ln(BLK)	.36 (3.33)	-.10 (-1.35)	.45 (7.35)
ln(DM/POP)	.25 (1.77)	.26 (2.71)	- ^a
CONSTANT	5.54 (2.02)	4.62 (2.49)	.88 (.60)
R ²	.68	.66	.60
SEE	.87	.59	.49
Mean of dependent variable	5.56	3.18	2.35

^aIf ln(DM/POP) is included in the equation for HSG IIIL-IV/POP the coefficient is -.03 and the t statistic is -.17. The change in the coefficients on the other variables is negligible.

coefficient is very close to zero and clearly insignificant. Holding the demographic and economic variables (including the ratio of civilian to military pay) for each district fixed at their 1979 values, the aggregate number of recruits — given an optimal allocation of resources — can now be written as follows:*

$$(1) \text{ HSG } 1-3U = -133833 + 12160.1 \ln R_T + 2749.2 \ln DM_T$$

$$(2) \text{ HSG } 3L-4_T = -90731.4 + 10679.74 \ln R_T.$$

Given that the supply equation for HSGs in categories 1-3U includes a variable which does not affect the number of HSGs in categories 3L-4, it proves possible to estimate a cost function where a positive marginal cost for recruits in one mental group does not imply a zero marginal cost for recruiters in the other group. So long as the number in the upper mental group is greater than $-5101 + 1.14 \times \text{HSG } 3L-4$ and is less than $9313.7 + 1.40 \times \text{HSG } 3L-4$, the marginal cost of obtaining both types of recruits is positive.** Within these bounds, the optimal allocation

*This aggregation takes advantage of the fact that the optimal allocation of recruiters and direct mail will be proportional to population.

** These bounds are found by solving for the least cost combination of resources necessary to obtain a specific types of recruit and then determining the number of recruits in the other group which would be forthcoming given that combination of resources.

of resources is determined by the following equations:*

$$R_T = e \frac{\text{HSG 3L-4} + 90731}{10679.7} \quad \text{and}$$

$$DM_T = e \left(\frac{\text{HSG 1-3U}}{2777.7} - \frac{\text{HSG 3L-4}}{2415.4} + 11.13 \right)$$

The minimum cost of the resources necessary to recruit HSG 1-3U and HSG 3L-4 is:

$$\begin{aligned} \text{Cost (HSG 1-3U, HSG 3L-4)} = & 2170 e \frac{\text{HSG 3L-4} + 90731.4}{10679.7} \\ & + 1.2 e \left(\frac{\text{HSG 1-3U}}{2777.7} - \frac{\text{HSG 3L-4}}{2415.4} + 11.13 \right) \end{aligned}$$

Based on this revised cost function, table B-5 shows how the marginal costs of obtaining upper and lower mental group recruits change as the desired recruit mix is altered.

TABLE B-5

Total HSG	(a) # HSG 3L-4	(b) # HSG 1-3U	(c) Marginal cost HSG 3L-4	(d) Marginal cost HSG 1-3U
50	22,000	28,000	\$7,712	\$ 78
50	20,000	30,000	6,049	365
50	18,000	32,000	3,384	1,721
50	17,700	32,300	2,723	2,167
50	17,000	33,000	604	3,725

*Found by minimizing cost (where cost = 2170 x R_T + 1.2 DM_T) subject to the two equality constraints represented by equations (1) and (2) above.

When we simply minimize the cost of obtaining HSGs as a group, working from the supply function shown in column a of table B-4, the proportion of upper mental group recruits which emerges is described by the following relationship: $HSG_{1-3U} = 2817.6 HSG_T$. With 50,000 total HSG recruits, 32,300 would be in mental groups 1-3U. As indicated (somewhat roughly) in table B-5, it is at this mix that the marginal costs of obtaining upper and lower mental group recruits are equal.* This suggests that so long as the marginal value to the Navy of an upper mental group HSG recruit is greater than the marginal value of a lower mental group HSG recruit, a cohort of 50,000 NPS male HSG recruits should contain at least 32,300 individuals from the upper mental groups.

Both of our efforts to estimate recruiting costs as a function of recruit quality yield disturbing results. According to our first estimate, additional HSG recruits can be obtained at least cost of the proportion of these recruits who are in mental groups 1-3U is 57 percent. According to our second estimate, additional HSG recruits can be obtained at least cost if 59 percent of the recruits are in the upper mental groups.

* This provides a useful validation of the derivation used to obtain the cost function shown on page 21.

Given that 54 percent of U.S. male population between the ages of 17 and 23 will score in the upper mental categories,* it is not really disturbing that a recruit cohort in which 90 percent of the individuals must be in the lower mental categories should be more expensive to obtain than a more eventually balanced cohort. It is nonetheless surprising, in view of the different civilian opportunities available to individuals in the upper and lower mental categories, that a recruit cohort can be increased at least cost if between 57 and 59 percent of the additional recruits are in the upper mental groups. Further, it is disturbing that this result should depend in large part on the apparent ability of additional recruiters to attract more upper than lower mental group recruits.

One might argue that, as recruiters are instructed to bring in a high proportion (currently 60 percent) of upper mental group individuals, they adjust their recruiting efforts to meet this goal. If their allocation of effort were to change, so too would the coefficients on recruits in the supply equations for HSGs 1-3U and HSGs 3L-4,** and with this our estimate of the least-cost mix of recruits. A

* See [3].

** The difficulty is, of course, that the supply equations have been estimated using the observable variable "recruiters" rather than the unobservable variable, "recruiter effort." This does not have the same implications as would the assumption that HSGs in mental groups 3L-4 are demand limited. In the case of demand limitation, the marginal cost of the limited group is zero. If the issue is instead one of recruiter effort, the marginal cost of obtaining these recruits is positive but cannot be determined directly from a supply equation which is estimated using number of recruiters.

test of this hypothesis would require time series data encompassing a number of distinct policy shifts. If in response to a new policy the coefficients on recruiters in the supply equations for HSGs 1-3U and HSGs 3L-4 were to change in opposite directions, the relative magnitudes of these changes might provide a guide to the amount of recruiter effort required to obtain HSGs in the upper mental categories as opposed to the lower.

Without additional data on recruiter effort, we believe that it is inappropriate to attempt to identify recruiting costs as a function of the recruit quality mix. Fortunately, a distinction between recruiter effort and recruiters will not affect the ability of the estimated supply equations to predict the number of HSGs, HSGs in categories 1-3U and HSGs in categories 3L-4 so long as the relationship between the number of recruiters and the amount of recruiter effort devoted to each group remains constant. In addition, there was little variation in the recruit mix over the period from which our data are obtained. Thus — if we assume that the existing relationship between recruiters and recruiter effort is designed to obtain this historical mix at least cost — the supply function for HSGs as a group can be used to derive a cost function which specifies the minimum cost of obtaining different numbers of recruits, taking the prevailing mix of recruits as given. This is the approach adopted in the NACCS study.

APPENDIX C
 CALCULATION OF AFEES PROCESSING COSTS
 FOR HSDG AND NON-HSDG RECRUITS

Data is for FY 1980

Travel Costs

Cost of travel, lodging and subsistence for Navy NPS applicants:	\$4.399 million*
Number of Navy NPS applicants:	177K**
Travel cost per applicant:	\$25

Testing Costs

Cost of operating DoD AFEES:	\$35.191 million***
Total DoD applicants	769.1K**
Testing cost per applicant:	\$71

Cost Per Contract

NPS male HSDG Navy applicants:	73K**
NPS male HSDG Navy contracts:	57.3K**
Cost per NPS male HSDG Navy contract:	$\frac{73}{57.3} \times \$71 = \$90.$
NPS male non-HSDG Navy applicants:	74K**
NPS male non-HSDG Navy contracts:	21K**
Cost per NPS male non-HSDG Navy contract:	$\frac{74}{21} \times \$71 = \$250.$

* Data from Navy Recruiting Command.

** DMDC Data.

*** Data from Military Enlisted Personnel Processing Command.

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