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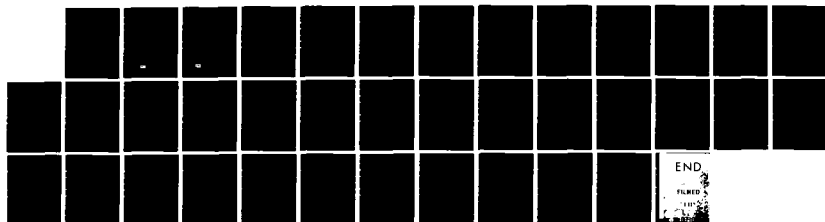
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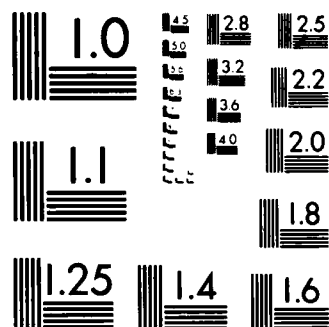
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Deborah Clay-Mendez

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A MINIMUM RECRUITING COST FUNCTION FOR MALE HIGH SCHOOL GRADUATES

Deborah Clay-Mendez



Naval Studies Group

CENTER FOR NAVAL ANALYSES

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A MINIMUM RECRUITING COST FUNCTION FOR MALE HIGH SCHOOL GRADUATES

INTRODUCTION AND SUMMARY OF FINDINGS

✓ In this paper we derive a cost function which specifies the minimum cost to the Navy of the recruiters and advertising necessary to attract different numbers of non-prior service male recruits who are high school graduates. This cost function is derived from a data base and a preliminary model of HSG recruit supply which were developed by Larry Goldberg at CNA for the Navy Enlisted Supply Study, [1].

The cost function can be adjusted to reflect alternative assumptions about future economic and demographic conditions. Taking advantage of this, we find that, because of increasing marginal recruiting costs, economic or demographic changes which would (with recruiting resources held constant) result in a relatively small percentage decline in the number of HSG recruits* will have a disproportionately large impact on the costs of meeting fixed recruiting goals. This may have important implications for the future of the AVF in an era of declining youth population.

* In the remainder of this paper, the term "HSG recruits" will refer to non-prior service male Navy recruits who are high school diploma or non-diploma (GED) graduates.

The estimates of current minimum recruiting costs provided by this function should also prove of value. They will be utilized in CNA's Navy Comprehensive Compensation and Supply Study - in conjunction with estimates of training costs and of the effectiveness of bonuses in stimulating reenlistments - to determine the least cost trade-off between accession and retention. In the future, along with estimates of the cost of obtaining lateral entrants or prior service males, they could be used to examine the trade-off between lateral entry and the current policy of assessing and training inexperienced recruits.

In considering this cost function, the reader should bear in mind that its focus is on the budgetary costs of recruitment. While this makes the cost function an appropriate tool for Navy decision-makers, the trade-off between compensation (whether in the form of enlistment bonuses or pay increases) and other recruiting tools would be different if weight were given to real resource costs as opposed to budgetary costs. Evidence is presented indicating that - from the perspective of society as a whole - compensation is underutilized as a recruiting tool, which recruiters and advertising are over-utilized. This is true even though we conclude that enlistment bonuses are not a cost-effective recruiting tool when viewed from the Navy's budgetary perspective. It is a problem of which the Navy and the Congress should be aware. It may be aggravated in the future as changing demographic conditions raise the budgetary costs of recruiting.

The Underlying Supply Function

Our estimate of the cost of recruiting NPS male HSGs is derived from a preliminary model of Navy recruit supply which was developed by Larry Goldberg of CNA for the Navy Enlisted Supply study. This model predicts the number of HSG contracts relative to the male population aged 17-21 in each Navy Recruiting District (HSG/POP). The equations were estimated using OLS and pooled cross section, time series data which cover each of the 43 districts in 1977, 1978, 1979.

$$\begin{aligned} 1) \quad \frac{\text{HSG}}{\text{POP}} &= 4.39 + 2.96 \ln\left(\frac{\text{R}}{\text{POP}}\right) - 4.87 \ln \text{PAY RATIO} \\ &\quad + 1.82 \ln\left(\frac{\text{AIRFR}}{\text{POP}}\right) - .72 \ln\left(\frac{\text{CC}}{\text{POP}}\right) - .37 \ln\left(\frac{\text{CY}}{\text{POP}}\right) \\ &\quad + .97 \ln\left(\frac{\text{L}}{\text{POP}}\right) + 2.36 \ln \text{UNEMP} + u \\ \\ 2) \quad \ln\left(\frac{\text{L}}{\text{POP}}\right) &= -1.97 - 1.31 \ln \text{PAY RATIO} + .28 \ln \text{UNEMP} \\ &\quad + .27 \ln\left(\frac{\text{CY}}{\text{POP}}\right) + .094 \ln\left(\frac{\text{CC}}{\text{POP}}\right) + .25 \ln\left(\frac{\text{TVR}}{\text{POP}}\right) \\ &\quad + .10 \ln\left(\frac{\text{AD}}{\text{POP}}\right) + \varepsilon \end{aligned}$$

Definitions of the variables and the values of the t statistics are provided in tables 1a and 1b. A reduced form equation for HSG/POP is obtained by substituting the second equation into the first. This two-equation structural model incorporates the view that advertising affects the number of contracts only through its impact on leads and that all

TABLE 1a
DEFINITION OF VARIABLES^a

<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 CETA countercyclical programs
CY	Expenditures on CETA youth programs
UNEMP	Civilian unemployment rate
L	Contacts with potential recruits obtained through advertising
TVR	Expenditures on television and radio advertising
AD	Expenditures on magazine, billboard, and direct mail advertising

^a These data are from the data base developed by Larry Goldberg of CNA
for the Navy Enlisted Supply Study.

TABLE 1b

PRELIMINARY SUPPLY MODEL
FOR NPS MALE HSG CONTRACTS^a

Explanatory variables ^b	Equation 1 Dependent variable: HSG/POP		Equation 2 Dependent variable: $\ln(L/POP)$		Equation 3 HSG/POP (reduced form obtained by substitution of equation 2 into equation 1)
	Coefficient	(t(121))	Coefficient	(t(122))	
$\ln(R/POP)$	2.96	5.51			2.96
$\ln(PAYRATIO)$	-4.87	-5.55	-1.31	-5.02	-6.14
$\ln(AIRFR/POP)$	1.82	3.21			1.82
$\ln(CC/POP)$	-.72	-2.93	.09	1.15	-.63
$\ln(CY/POP)$	-.37	-.83	.27	1.91	-.11
$\ln UNEMP$	2.36	6.89	.28	2.43	2.63
$\ln(L/POP)$	.97	3.45			
$\ln(TVR/POP)$			.25	2.16	.24
$\ln(AD/POP)$			.10	2.65	.10
CONSTANT	4.39	1.68	-1.97	-2.82	2.48
R ²	.71		.43		
SEE	.91		.28		
Mean of dependent variable	6.04		2.51		

^aThese are estimates of a preliminary supply model developed by Larry Goldberg for the Navy Enlisted Supply Study.

^b $\ln$ refers to the natural logarithm.

leads - regardless of source - are equally effective in generating contracts.*

Holding constant the economic and demographic variables not controlled by the Navy, the total number of HSG contracts obtained in any year is thus 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. As most of the national television and radio advertising is purchased through national networks - rather than being obtained via more expensive spot purchases from local stations - we assume that the Navy controls only the aggregate level of this advertising, with the distribution across districts determined by historical viewing and listening patterns.

Derivation of the Cost Function with Fixed Compensation

Fortunately, a minimum recruiting cost function for 1979 can be derived from an aggregate supply function which is based on only three variables: the aggregate number of recruiter man-months (R_T); aggregate expenditures on printed media advertising (AD_T); and the level of national advertising (TVR_T). This is because — given the functional

* In later work we modified this model, estimating the number of contracts directly as a function of the Navy advertising variables. While the coefficients of the advertising variables are sensitive to this alternative treatment, the basic form of the recruiting cost function and the major conclusions which we cite below are not affected.

form of the supply equation and given price estimates for recruiters and advertising which do not vary across districts* - equality in the ratio of prices to marginal products (a condition which holds when costs are minimized) implies that the ratio of recruiters to population and the ratio of advertising to population do not vary across districts. Multiplying each side of equation 3 on table 1a by population and aggregating across districts, we obtain the following equation:

$$HSG_T = -326719.2 + 31299.0 \ln R_T + 1057.4 \ln AD_T + 2537.8 \ln TVR_T \quad (1)$$

This is a relationship that holds when costs are minimized. The constant term incorporates the effects of the economic and demographic variables which enter into equation 3 in table 1b but which are not directly controlled by the Navy.** This constant is calculated using the 1979 value for these variables.

* The estimated annual marginal cost of a Navy recruiter in 1979 is \$26,000 (see appendix A). The estimated cost per recruiter man month is thus \$2,170. Each unit of advertising - printed or national - costs 1.2 1979 dollars. The figure 1.2 represents an inflation adjustment; this is necessary as the supply equations are estimated using expenditures on advertising in 1977 dollars.

** This includes military pay. Allowing the Navy to raise compensation by giving enlistment bonuses does not change the cost function (see p. 15, below).

We now equate the ratios of prices to marginal products for the aggregate recruiting variables to obtain the following relations:*

$$AD_T = 61.1 \times R_T \quad (2)$$

$$TVR_T = 152.7 \times R_T \quad (3)$$

Substituting (2) and (3) for AD_T and TVR_T in equation (1) and solving for R_T yields:

$$R_T = e \frac{HSG_T + 309599.7}{34894.2} \quad (4)$$

The cost of recruiting and advertising resources is:

$$TC = 2170 \times R_T + 1.2 AD_T + TVR_T. \quad (5)$$

Using (2) and (3) to substitute for AD_T and TVR_T in equation (5) and then substituting (4) for R_T , the final form of the minimum recruiting cost function emerges:

$$\text{Minimum Cost} = 2426.5 \times e \frac{HSG_T + 309599.7}{34894.2}$$

$$* \frac{31299.0}{R_T \times 2170} = \frac{1057.4}{AD_T \times 1.2} = \frac{2537.8}{TVR_T \times 1.2}$$

The Actual vs. The Optimal Allocation of Recruiters and Advertising

Table 2, which is based on this cost function, shows the minimum recruiting costs associated with different numbers of HSG contracts, together with the optimal number of recruiters and the optimal levels of advertising expenditures. The minimum expenditure necessary to obtain 58,000 recruits in 1979 was 91.2 million dollars. This includes expenditures on printed advertising of 2.8 million dollars and on national advertising of 6.8 million. 3,133 recruiters account for 90 percent of the total minimum cost. The resources actually utilized to obtain 58,000 HSG recruits in 1979 include 3,454 recruiters, 6.1 million dollars of national advertising and .9 million of printed media advertising. The estimated cost of these resources is 96.9 million. From this cost function, we conclude that recruiting resources were reasonably well allocated, although a shift away from recruiters and toward printed advertising would have saved approximately 5 million dollars.

TABLE 2
RECRUITING COST SCHEDULE BASED ON
1979 ECONOMIC AND DEMOGRAPHIC CONDITIONS

(All values in 1979 dollars)

<u>NPS</u>	<u>Recruiters (in man-years)</u>	<u>Expenditures on printed advertising (\$ millions)</u>	<u>Expenditures on national TV and radio (\$ millions)</u>	<u>Total cost</u>	<u>Marginal cost</u>
50,000	2,491	2.1	5.5	72.5	2,049
55,000	2,875	2.5	6.4	83.7	2,365
58,000	3,133	2.8	6.8	91.2	2,729
60,000	3,317	2.9	7.3	96.6	2,808
65,000	3,829	3.4	8.4	111.5	3,150
70,000	4,419	3.8	9.7	128.7	3,635
75,000	5,099	4.4	11.2	148.5	4,195
80,000	5,885	5.2	12.9	171.4	4,842
85,000	6,792	6.0	14.9	197.8	5,587

The Costs Associated with Changing Economic and Demographic Conditions

Table 3 shows the impact on recruiting costs of a 17 percent decline in the male population aged 17 to 21, a decline which is projected to take place by 1980. With an initial recruiting level of 60,000 for NPS male HSGs, the 17 percent population decline would result in a 5 percent drop in the number of these recruits (holding recruiting resources and the ratio of military to civilian pay constant). The increase in total cost necessary to maintain a recruiting level of 60,000 is 11 percent, however, and with a larger recruit cohort (80,000) the percentage increase in total costs necessary to offset the 17

percent population decline rises to 25 percent.* In general, since marginal costs are increasing, the percentage increase in recruiting expenditures necessary to maintain recruiting levels will be greater than the percentage decrease in recruits which would result from a demographic or economic change with recruiting resources held constant.

TABLE 3
MINIMUM RECRUITING COST SCHEDULE GIVEN A
17 PERCENT DECLINE IN THE POPULATION AGED 17-21

(Other variables held at 1979 levels)

<u>NPS</u>	<u>Recruiters (in man-years)</u>	<u>Expenditures on printed advertising (\$ millions)^a</u>	<u>Expenditures on national TV and radio (\$ millions)</u>	<u>Total cost</u>	<u>Marginal cost</u>
50,000	2,608	2.3	5.8	76.0	2,490
55,000	3,100	2.8	6.8	90.3	3,064
60,000	3,684	3.2	8.0	107.3	3,641
65,000	4,378	3.8	9.6	127.5	4,327
70,000	5,203	4.6	11.4	151.5	5,143
75,000	6,184	5.4	13.6	180.1	6,112
80,000	7,350	6.5	16.2	214.0	7,264
85,000	8,734	7.7	19.2	254.3	8,632

^aAll expenditures in 1979 dollars.

Recruiting Costs with Variable Compensation

If adjustments in compensation as well as in the level of recruiters and advertising are viewed as a recruiting tool the

* This does not take into account the cost of maintaining a fixed ratio of civilian to military pay.

derivation of a recruiting cost function becomes more complex. One issue that arises is the impact of a pay increase on enlistments relative to the impact of a bonus.

Although this is an empirical question, there is little direct evidence on which to base a judgement. One frequently used indirect approach is to assume that the ratio of annual civilian to military pay in the recruit supply equation (PAYRATIO) represents the ratio of the PDV of civilian earnings relative to the PDV of military compensation over the recruits' first four-year term:

$$\text{PAYRATIO} = \text{CIVPAY} \sum_{t=0}^3 (1+r_t)^{-t} / \text{MILPAY} \sum_{t=0}^3 (1+r_t)^{-t},$$

where r_t is the discount rate less the rate of real wage growth. (This equality assumes that r_t for $t=0,3$ is the same in the military as in the civilian sector.) Under this approach, a military pay raise of \$100 will have the same impact as a bonus with the same PDV $(100 \sum_{t=0}^3 (1+r)^{-t})$.

The problem of selecting an appropriate discount rate remains. Surveys of military personnel in which individuals are asked to choose between bonuses and pay increases indicate that first term personnel have high discount rates, with estimates ranging from 20 to 28 percent [2]. At the same time, it is conventional to assume a 10 percent discount rate for the Navy. The discrepancy between these discount rates leads to the anomalous conclusion that the Navy will meet its

recruiting goals while minimizing the PDV of compensation (using the 10 percent rate) if all compensation is given in the form of enlistment bonuses. In order to provide a more realistic problem, we will simply assume that a minimum level of pay (the actual level for 1979) is to be given and then consider the optimal enlistment bonus, if any.

Taking this approach, we find that even if recruits are assumed to have a one-year time horizon* - so that a \$100 bonus has the same impact as a \$100 per year pay increase - the use of a general enlistment bonus for HSGs is not cost-effective from the Navy's perspective. With a recruit cohort of 60,000 and a 1979 pay level of \$7,617, the cost to the Navy of attracting an additional HSG using an enlistment bonus is approximately \$7,000,** this is \$4,300 above the marginal cost shown in table 2, where the recruits are attracted using advertising and recruiters. As the cohort size increases, so does the marginal cost of

* The apparently extreme assumption may be warranted in view of a recent youth attitude survey [3] which indicates that a \$1,000 increase in level of enlistment bonuses would do more to increase the attractiveness of the military than would a pay raise of \$100 per month.

** When military compensation is allowed to vary and removed from the constant term, the aggregate equation for HSG's can be written:

$$\begin{aligned} \text{HSG}_T = & -907021.1 + 31299.0 \ln R + 1057.4 \ln AD + 2537.8 \ln TVR \\ & + 64924.4 \ln (\text{MILPAY}). \end{aligned}$$

Given our assumption with respect to the time horizon, the recruit is indifferent between a pay raise of \$100 and a bonus of \$100. MILPAY is thus equal to military pay plus the enlistment bonus. The marginal cost of a recruit attracted through an increase in MILPAY is:

$\partial \text{MILPAY} / \partial \text{HSG}_T \times \text{HSG}_T = 7617 / 64924.4 \times \text{HSG}_T = \$7,000$ for MILPAY = \$7,617 and $\text{HSG}_T = 60,000$. In order to make this marginal cost comparable to the costs shown in tables 2, 3, and 4, we do not include the cost of compensation (\$7,617) paid to the additional recruit.

TABLE 4

RECRUITING COST SCHEDULE GIVEN A 17 PERCENT DECLINE
IN POPULATION AND A 25 PERCENT RISE IN UNEMPLOYMENT

(Other variables held at 1979 levels)

<u>HSG</u>	<u>Recruiters (in man-years)</u>	<u>Expenditures on printed advertising (\$ millions)</u>	<u>Expenditures on national TV and radio (\$ millions)</u>	<u>Total cost</u>	<u>Marginal cost</u>
50,000	2,183	1.9	4.8	63.6	2,484
55,000	2,595	2.3	5.8	75.6	2,565
60,000	3,084	2.8	6.7	89.8	3,048
65,000	3,665	3.2	8.0	106.7	3,702
70,000	4,356	3.8	9.6	126.8	4,304
75,000	5,176	4.6	11.4	150.7	5,116
80,000	6,152	5.4	13.6	179.2	6,080
85,000	7,311	6.5	16.1	212.9	7,226

TABLE 5

RECRUITING COST SCHEDULE GIVEN A 17 PERCENT DECLINE
IN POPULATION AND A 25 PERCENT FALL IN UNEMPLOYMENT

(Other variables at 1979 levels)

<u>HSG</u>	<u>Recruiters (in man-years)</u>	<u>Expenditures on printed advertising (\$ millions)</u>	<u>Expenditures on national TV and radio (\$ millions)</u>	<u>Total cost</u>	<u>Marginal cost</u>
50,000	3,281	2.9	7.2	95.5	3,242
55,000	3,899	3.5	8.5	113.5	3,853
60,000	4,634	4.1	10.2	134.9	4,581
65,000	5,507	4.8	12.1	160.4	5,442
70,000	6,545	5.8	14.4	190.6	6,468
75,000	7,778	6.8	17.0	226.5	7,687
80,000	9,244	8.2	19.2	269.2	9,135

a recruit obtained by means of a bonus. With a cohort of 80,000 and an initial military pay level of \$7,617, this cost rises to \$9,400. This is approximately \$4,600 above the corresponding marginal cost shown in table 2. If we assume that the recruits have a 20 percent discount rate, the cost of obtaining an additional NPS male HSG recruit by the use of an enlistment bonus is approximately 3.1 times as great in each of these situations, although the cost of obtaining a recruit through the use of recruiters and advertising would be unchanged.

Even under the adverse economic and demographic conditions which are assumed in table 5, compensation is unlikely to be a cost-effective recruiting tool so long as the objective is to meet recruiting goals while minimizing the budgetary cost to the Navy. In the face of increasing civilian pay, proportional increases in military compensation will avoid recruiting shortfalls, but not in the most cost-effective manner. We conclude that allowing the Navy to give enlistment bonuses which are greater than or equal to zero does not change our cost function, as the optimal level for such a bonus is zero.

Alternative Perspectives

In the above discussion, we have been concerned only with minimizing the budgetary costs incurred by the government in recruiting different numbers of HSGs. The reader should bear in mind that this is

not always an appropriate perspective to take. This is especially true when the level of military compensation is an issue.

There are two not unrelated alternatives. The first is that - while only costs and benefits to the Navy are considered - the Navy has an interest not only in obtaining recruits, but also in the general well-being of its first term personnel. This interest may be paternalistic and/or it may arise because of a correlation between the well-being and the performance of personnel. Insofar as expenditures on compensation contribute directly to the well-being of Navy personnel while expenditures on recruiters and advertising do not, this will alter the tradeoff between compensation and other recruiting tools. Without an estimate of the value which the Navy places on the additional compensation paid to its personnel, we can conclude only that the narrow perspective adopted in our previous calculation understates the merits of compensation relative to recruiters and advertising.

A second possible perspective is to focus on the real social resource costs - and the social benefits - associated with the use of compensation as opposed to other recruiting tools. While this is not a perspective which the Navy is likely to adopt in setting enlistment bonuses, it is a perspective that Congress might wish to consider - and that the Navy might urge Congress to consider - in setting compensation levels for military personnel.

The Navy finds that enlistment bonuses are not cost-effective because the bonus must be paid to all recruits, not only to the additional recruits attracted by the bonus. The budgetary cost incurred by the Navy in attracting $q_2 - q_1$ recruits by increasing compensation in this way is equal to the sum of areas A and B in figure 1.

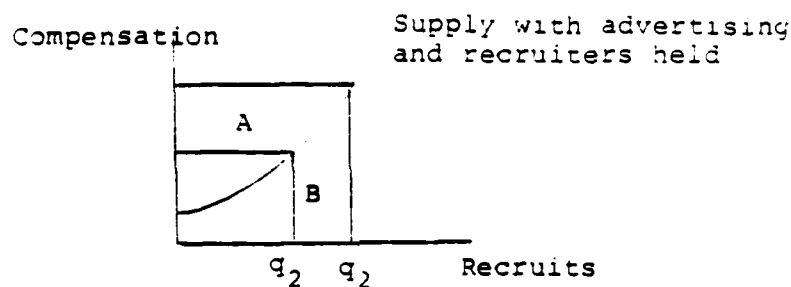


Figure 1

While area A is an expenditure from the Navy's perspective, it represents a transfer of resources from the taxpayer to the recruit rather than a real resource cost. The real resource cost is the value of the opportunities foregone when the Navy removes the $q_2 - q_1$ individuals from the civilian sector; this is equal to area B.*

If recruiters and advertising are used to attract recruits instead of compensation, the real resource cost will include - in addition to the civilian opportunities foregone by the recruits - the value of the resources utilized in the recruiting process itself. Thus, if resource

* More exactly, area B plus the cost of the resources utilized to raise revenue equal to $A+B$ and the welfare loss due to distortions imposed by this tax process.

transfers are viewed as costless, compensation emerges as the most cost-effective recruiting tool.*

In summary, the level of advertising, recruiting effort, and military compensation implied by the minimum recruiting cost function derived in this paper are not optimal from this social perspective. Nonetheless, they do provide a solution to the suboptimal problem which is faced by the Navy as it seeks to maximize readiness given its budgetary constraints. It is in the context of this suboptimal problem that the recruiting cost function should be applied.

* Even if resource transfers are costly, an argument in favor of compensation remains so long as society gives at least as much weight to a dollar received by a recruit as it does to a dollar saved by a taxpayer. Richard Musgrave [4] suggests that the welfare losses due to taxation in the U.S. - together with the costs of tax administration and compliance - amount to between 4 and 5 percent of tax revenue (a marginal estimate is not available). If we assume a 20 percent discount rate for recruits, the budgetary cost of obtaining an additional recruit by means of an enlistment bonus is on the order of \$21,000 ($\$21,000 \times 3.1 \times \$7000$ (see p. 15)). The social cost of this transfer is \$1,050, while the marginal cost associated with the use of recruiters and advertising is approximately \$2,700, or more than twice as much. Unless the last \$2,700 spent on recruiters and advertising provides \$1,500 worth of information, compensation is still to be preferred at the margin.

REFERENCES

- [1] CNA, Larry Goldberg, forthcoming
- [2] CNA, Working Paper 76-0984.20, "Determinants of Implicit Discount Rates: An Empirical Examination of the Pattern of voluntary Pension Contributions of Employees in Four Firms," by Harry J. Gilman, Unclassified, 20 Sep 1976
- [3] Market Facts, Inc., "Attitude Tracking Survey, Spring 1980," by Public Sector Research Group, Washington, D.C.
- [4] Musgrave, Richard and Peggy Musgrave, Public Finance in Theory and Practice, New York: McGraw-Hill, 1973, pp. 459-460

APPENDIX A

AN ESTIMATE OF THE MARGINAL COST OF A NAVY RECRUITER AND RECRUITER SUPPORT

SUMMARY

For fiscal year 1981, we estimate that the marginal cost to the government of an enlisted Navy recruiter, together with recruiter support, is approximately (\$31,500).^{*} There are three principal components of this cost: 1) the cost of recruiter compensation and training; 2) the cost of direct recruiter support in the form of vehicles, telephone services, and office space; 3) the cost of indirect recruiter support in the form of enlisted support personnel.

The first of these components is the marginal cost of a recruiter alone - holding constant vehicles, telephone services, office space and support personnel. In FY 1981, this component will amount to approximately \$20,000. The second two components are not part of the strict marginal cost of a recruiter. Yet as the ratios of both direct and indirect recruiter support to recruiters have been maintained at relatively constant levels as a matter of policy, one cannot identify the marginal product of a recruiter while holding constant the absolute quantity of these other inputs. In order to have an estimate of

^{*}In order to obtain the estimate of \$26,000 for 1979, we deflated support costs by 8 percent each year and deflated compensation by 11.7 percent for 1980-81 and 7 percent for 1979-1980.

marginal cost which is consistent with the estimates of marginal products made at CNA (reference 1) and elsewhere (reference 2), we have calculated the marginal cost of a recruiter under the assumption that these ratios remain constant.

A BREAKDOWN OF THE MARGINAL COST

COMPENSATION AND TRAINING

Recruiter compensation and training account for over half of the total marginal cost. It can be broken down as follows:

Direct compensation	
Basic pay	11,600
BAQ	3,100
BAS	1,400
VHA	600
SDA	<u>1,600</u>
	\$18,300
Indirect compensation	
Pension rights	\$1,000
Training	700
Total	\$20,000

In estimating the level of compensation, we assume that the recruiter is an E-6 with dependents who receives the BAQ and BAS. The expected cost of the VHA is calculated on the assumption that the proportion of recruiters receiving the VHA is the same as the overall proportion of E-6 personnel who receive that allowance. SDA refers to

special duty assignment pay; the figure shown is the average amount received by Navy recruiters.

Indirect compensation is received in the form of pension rights. The annual value of these rights is calculated by asking how much the recruiter would need to save each year during twenty years of service in order to accumulate a 30 year pension equal to 1/2 of his base pay. (He is assumed to retire as an E-7 with a base pay of \$14,100 and to live for 30 years after retirement.)

$$\int_{20}^{50} 7,000 e^{-rt} dt = \int_0^{20} N e^{-rt} dt$$

Solving this with an interest rate (r) of 10 percent, we find that the salary equivalent of the pension rights is approximately \$1,000.

The cost of recruiter training contributes an additional \$700 dollars to the annual marginal cost of a recruiter. Recruiters receive a five week training course at the beginning of their tour. School operating costs plus the recruiter's salary and a \$14 per diem allowance for this period amount to approximately \$2,300. (This cost estimate was provided by the comptroller at NRC.) The annual figure of \$700 is calculated assuming a 10 percent interest rate and an average tour of three years.

DIRECT RECRUITER SUPPORT

The average (and marginal) annual cost of recruiter support, as estimated by the NRC Comptroller's Office for FY 1981, is approximately \$6,000. It includes the following:

	<u>Cost per enlisted recruiter</u>
Vehicles	\$2,800
Communications	1,100
Supplies	400
Printing	100
Out of pocket expenses	400
Facilities, furnishings	100
TAD	600
Other purchased services	500
Total	<u>\$6,000</u>

An additional element in direct recruiter support, although one which does not appear in the NRC budget, is the cost of office space. There is no reliable data on this cost to the government. The comptroller at NRC suggests that an estimate of \$800 per recruiter year be utilized. This is based on an allowance of 400 sq. ft. per recruiter, at \$2.00 per sq. foot. This yields an over-all estimate for the cost of direct support of \$6,800.

It would be possible, of course, to increase the number of recruiters without increasing expenditures on direct recruiter support, or without increasing them proportionately. Yet our estimates of the

marginal productivity of Navy recruiters reflect the existing relationships between recruiters and these elements of recruiter support. These relationships are relatively stable; the largest single component of support costs, the cost of vehicles, reflects a conscious policy which allocates seven vehicles to every ten enlisted recruiters. As a result, it is appropriate to consider not simply the marginal cost of a recruiter, but the marginal cost of a recruiter together with the cost of the direct support services which he receives.

ENLISTED SUPPORT PERSONNEL

The final cost element which we consider is the cost of the additional enlisted support personnel (principally clerical workers) associated with the marginal recruiter. Between FY 1974 and FY 1981 the ratio of enlisted support personnel to enlisted canvassers has ranged between .27 and .34, with a mean of .31. A deliberate effort is made to hold this ratio constant, both over time and between recruiting districts. As a result, existing estimates of the marginal product of a Navy recruiter include the contribution of the associated support personnel. To be consistent, the cost of the support personnel associated with a recruiter must also be included in our estimate of marginal cost.

We assume that support personnel have a pay grade of E-5 and receive the BAQ and BAS. The cost of the VHA is calculated on the

assumption that the proportion receiving this allowance is the same as the overall proportion of E-5s who receive that allowance. The value of pension rights is calculated as before. Finally, in accordance with NRC budgeting procedure, we allow for each support person 7 percent of the direct support cost allowed each recruiter.

THE MARGINAL COST OF SUPPORT PERSONNEL

Basic pay	\$9,200
BAQ	2,800
BAS	1,400
VHA	500
Pension rights	1,000
Support costs	<u>400</u>
Total	\$15,300

With the ratio of support personnel to enlisted recruiters held constant at .31, this contributes an additional \$4,700 to the cost of the marginal recruiter, bringing the overall cost of the marginal recruiter to \$31,500.

A POSSIBLE RANGE OF VALUES

This estimate of \$31,500 is an extremely rough one. As noted above, it is an estimate of the marginal cost of a recruiter when the ratio of direct support to recruiters and the ratio of support personnel to recruiters are held constant. This approach, which is taken because estimates of the marginal product of a recruiter also hold these ratios constant, does introduce a possible bias. It may be that support

personnel are involved principally in processing applicants. If so, they may not contribute to the number of high quality applicants attracted by Navy recruiters. In this case, treating recruiters and support personnel as a unit with a single marginal product and marginal cost will lead to an upward bias in estimates of the cost of recruiting high quality individuals relative to lower quality individuals. To avoid this possibility, one might wish to assume that the marginal cost corresponding to CNAs estimate of the marginal product of a recruiter lies somewhere within the range from \$26,800 to \$31,500, where \$26,800 is the cost of compensation, training, and direct recruiter support for the marginal recruiter.

REFERENCES

- [A-1] CNA, Memorandum 81-0601, "Navy Enlisted Supply Study, (Briefing to the Navy Recruiting Command), by Lawrence Goldberg, Unclassified, Apr 1981
- [A-2] Morey, Richard, "The Impacts of Various Types of Advertising Media, Demographics, and Recruiters on Quality Enlistments: Results from Simultaneous and Heteroscedastic Models," Center for Applied Business Research, Graduate School of Business, Duke University, Jul 1980

CNA PROFESSIONAL PAPERS - 1978 TO PRESENT*

- PP 211
Mizrahi, Maurice M., "On Approximating the Circular Coverage Function," 14 pp., Feb 1978, AD A054 429
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Mangel, Marc, "Fluctuations in Systems with Multiple Steady States. Application to Lanchester Equations," 12 pp., Feb 78 (Presented at the First Annual Workshop on the Information Linkage Between Applied Mathematics and Industry, Naval PG School, Feb 23-25, 1978), AD A071 472
- PP 214
Weinland, Robert G., "A Somewhat Different View of The Optimal Naval Posture," 37 pp., Jun 1978 (Presented at the 1976 Convention of the American Political Science Association (APSA/IUS Panel on "Changing Strategic Requirements and Military Posture"), Chicago, Ill., September 2, 1976), AD A056 228
- PP 215
Colle, Russell C., "Comments on: Principles of Information Retrieval by Manfred Kochen," 10 pp., Mar 78 (Published as a Letter to the Editor, Journal of Documentation, Vol. 31, No. 4, pages 298-301), December 1975), AD A054 426
- PP 216
Colle, Russell C., "Lotka's Frequency Distribution of Scientific Productivity," 18 pp., Feb 1978 (Published in the Journal of the American Society for Information Science, Vol. 28, No. 6, pp. 366-370, November 1977), AD A054 425
- PP 217
Colle, Russell C., "Bibliometric Studies of Scientific Productivity," 17 pp., Mar 78 (Presented at the Annual Meeting of the American Society for Information Science held in San Francisco, California, October 1976), AD A054 442
- PP 218 - Classified
- PP 219
Huntzinger, R. LaVar, "Market Analysis with Rational Expectations: Theory and Estimation," 60 pp., Apr 78, AD A054 422
- PP 220
Maurer, Donald E., "Diagonalization by Group Matrices," 26 pp., Apr 78, AD A054 443
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Weinland, Robert G., "Superpower Naval Diplomacy in the October 1973 Arab-Israeli War," 76 pp., Jun 1978 (Published in Seapower in the Mediterranean: Political Utility and Military Constraints, The Washington Papers No. 61, Beverly Hills and London: Sage Publications, 1979) AD A055 564
- PP 222
Mizrahi, Maurice M., "Correspondence Rules and Path Integrals," 30 pp., Jun 1978 (Invited paper presented at the CNRS meeting on "Mathematical Problems in Feynman's Path Integrals," Marseille, France, May 22-26, 1978) (Published in Springer Verlag Lecture Notes in Physics, 106, (1979), 234-253) AD A055 536
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Mangel, Marc, "Stochastic Mechanics of Molecule-Molecule Reactions," 21 pp., Jun 1978, AD A056 227
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Mangel, Marc, "Aggregation, Bifurcation, and Extinction in Exploited Animal Populations," 48 pp., Mar 1978, AD A058 536
*Portions of this work were started at the Institute of Applied Mathematics and Statistics, University of British Columbia, Vancouver, B.C., Canada
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Mangel, Marc, "Oscillations, Fluctuations, and the Hopf Bifurcation," 43 pp., Jun 1978, AD A058 537
*Portions of this work were completed at the Institute of Applied Mathematics and Statistics, University of British Columbia, Vancouver, Canada.
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Mangel, Marc, "Diffusion Theory of Reaction Rates, II Ornstein-Uhlenbeck Approximation," 34 pp., Feb 1978, AD A058 542
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Wilson, Desmond P., Jr., "Naval Projection Forces: The Case for a Responsive MAF," Aug 1978, AD A054 543
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Mizrahi, Maurice M., "The Semiclassical Expansion of the Anharmonic-Oscillator Propagator," 41 pp., Oct 1978 (Published in Journal of Mathematical Physics 20 (1979) pp. 844-855), AD A061 538
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Utgoff, Kathleen Classen, "Unemployment Insurance and The Employment Rate," 20 pp., Oct 1978 (Presented at the Conference on Economic Indicators and Performance: The Current Dilemma Facing Government and Business Leaders, presented by Indiana University Graduate School of Business). AD A061 527
- PP 239
Trost, R. P. and Warner, J. T., "The Effects of Military Occupational Training on Civilian Earnings: An Income Selectivity Approach," 38 pp., Nov 1979k, AD A077 831
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Powers, Bruce, "Goals of the Center for Naval Analyses," 13 pp., Dec 1978, AD A063 759
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Mangel, Marc, "Fluctuations at Chemical Instabilities," 24 pp., Dec 1978 (Published in Journal of Chemical Physics, Vol. 69, No. 8, Oct 15, 1978). AD A063 787
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Simpson, William R., "The Analysis of Dynamically Interactive Systems (Air Combat by the Numbers)," 160 pp., Dec 1978, AD A063 760
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Simpson, William R., "A Probabilistic Formulation of Murphy Dynamics as Applied to the Analysis of Operational Research Problems," 18 pp., Dec 1978, AD A063 761
- PP 244
Sherman, Allen and Horowitz, Stanley A., "Maintenance Costs of Complex Equipment," 20 pp., Dec 1978 (Published By The American Society of Naval Engineers, Naval Engineers Journal, Vol. 91, No. 6, Dec 1979) AD A071 473
- PP 245
Simpson, William R., "The Accelerometer Methods of Obtaining Aircraft Performance from Flight Test Data (Dynamic Performance Testing)," 403 pp., Jun 1979, AD A075 226
- PP 246
Brechling, Frank, "Layoffs and Unemployment Insurance," 35 pp., Feb 1979 (Presented at the Nber Conference on "Low Income Labor Markets," Chicago, Jun 1978), AD A096 629
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Thomas, James A., Jr., "The Transport Properties of Dilute Gases in Applied Fields," 183 pp., Mar 1979, AD A096 464
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Glasser, Kenneth S., "A Secretary Problem with a Random Number of Choices," 23 pp., Mar 1979
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- PP 253
Glasser, Kenneth S., "The d-Choice Secretary Problem," 32 pp., Jun 1979, AD A075 225
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Mangel, Marc and Quenbeck, David B., "Integration of a Bivariate Normal Over an Offset Circle," 14 pp., Jun 1979, AD A096 471
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Thaler, R., "Discounting and Fiscal Constraints: Why Discounting is Always Right," 10 pp., Aug 1979, AD A075 224
- PP 258
Mangel, Marc S. and Thomas, James A., Jr., "Analytical Methods in Search Theory," 86 pp., Nov 1979, AD A077 832
- PP 259
Glass, David V.; Hsu, Ih-Ching; Nunn, Walter R., and Perlin, David A., "A Class of Commutative Markov Matrices," 17 pp., Nov 1979, AD A077 833
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Mangel, Marc S. and Cope, Davis K., "Detection Rate and Sweep Width in Visual Search," 14 pp., Nov 1979, AD A077 834
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Villa, Carlos L.; Zvijac, David J. and Ross, John, "Frank-Condon Theory of Chemical Dynamics. VI. Angular Distributions of Reaction Products," 14 pp., Nov 1979 (Reprinted from Journal Chemical Phys. 70(12), 15 Jun 1979), AD A076 287
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Petersen, Charles C., "Third World Military Elites in Soviet Perspective," 50 pp., Nov 1979, AD A077 835
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- PP 265
Weinland, Robert G., "War and Peace in the North: Some Political Implications of the Changing Military Situation in Northern Europe," 18 pp., Nov 1979 (Prepared for presentation to the Conference of the Nordic Balance in Perspective: The Changing Military and Political Situation, Center for Strategic and International Studies, Georgetown University, Jun 15-16, 1978) AD A077 838
- PP 266
Utgoff, Kathy Classen, and Brechling, Frank, "Taxes and Inflation," 25 pp., Nov 1979, AD A081 194
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Trost, Robert P., and Vogel, Robert C., "The Response of State Government Receipts to Economic Fluctuations and the Allocation of Counter-Cyclical Revenue Sharing Grants," 12 pp., Dec 1979 (Reprinted from the Review of Economics and Statistics, Vol. LXI, No. 3, August 1979)
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Thomson, James S., "Seaport Dependence and Inter-State Cooperation: The Case of Sub-Saharan Africa," 141 pp., Jan 1980, AD A081 193
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Weiss, Kenneth G., "The Soviet Involvement in the Ogaden War," 42 pp., Jan 1980 (Presented at the Southern Conference on Slavic Studies in October, 1979), AD A082 219
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- PP 271
McConnell, James, "Soviet and American Strategic Doctrines: One More Time," 43 pp., Jan 1980, AD A081 192
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Weiss, Kenneth G., "The Azores in Diplomacy and Strategy, 1940-1945," 46 pp., Mar 1980, AD A085 094
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Nakada, Michael K., "Labor Supply of Wives with Husbands Employed Either Full Time or Part Time," 39 pp., Mar 1980, AD A082 220
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Goldberg, Lawrence, "Recruiters Advertising and Navy Enlistments," 34 pp., Mar 1980, AD A082 221
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Goldberg, Lawrence, "Delaying an Overhaul and Ship's Equipment," 40 pp., May 1980, AD A085 095
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Mangel, Marc, "Small Fluctuations in Systems with Multiple Limit Cycles," 19 pp., Mar 1980 (Published in SIAM J. Appl. Math., Vol. 38, No. 1, Feb 1980) AD A086 229
- PP 278
Mizrachi, Maurice, "A Targeting Problem: Exact vs. Expected-Value Approaches," 23 pp., Apr 1980, AD A085 096
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Walt, Stephen M., "Causal Inferences and the Use of Force: A Critique of Force Without War," 50 pp., May 1980, AD A085 097
- PP 280
Goldberg, Lawrence, "Estimation of the Effects of A Ship's Steaming on the Failure Rate of Its Equipment: An Application of Econometric Analysis," 25 pp., Apr 1980, AD A085 098
- PP 281
Mizrachi, Maurice M., "Comment on 'Discretization Problems of Functional Integrals in Phase Space'," 2 pp., May 1980, published in "Physical Review D", Vol. 22 (1980), AD A094 994
- PP 283
Dismukes, Bradford, "Expected Demand for the U.S. Navy to Serve as An Instrument of U.S. Foreign Policy: Thinking About Political and Military Environmental Factors," 30 pp., Apr 1980, AD A085 099
- PP 284
J. Kellison,* W. Nunn, and U. Sumita,** "The Laguerre Transform," 119 pp., May 1980, AD A085 100
*The Graduate School of Management, University of Rochester and the Center for Naval Analyses
**The Graduate School of Management, University of Rochester
- PP 285
Remnek, Richard B., "Superpower Security Interests in the Indian Ocean Area," 26 pp., Jun 1980, AD A087 113
- PP 286
Mizrachi, Maurice M., "On the WKB Approximation to the Propagator for Arbitrary Hamiltonians," 25 pp., Aug 1980 (Published in Journal of Math. Phys., 22(1) Jan 1981), AD A091 307
- PP 287
Cope, Davis, "Limit Cycle Solutions of Reaction-Diffusion Equations," 35 pp., Jun 1980, AD A087 114
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Thomas, James A., Jr., "Evaluation of Kinetic Theory Collision Integrals Using the Generalized Phase Shift Approach," 12 pp., Sept 1980 (Printed in Journal of Chemical Physics 72(10), 15 May 1980)
- PP 294
Roberts, Stephen S., "French Naval Policy Outside of Europe," 30 pp., Sept 1980 (Presented at the Conference of the Section on Military Studies, International Studies Association Kluwer Island, S.C.), AD A091 306
- PP 295
Roberts, Stephen S., "An Indicator of Informal Empire: Patterns of U.S. Navy Cruising on Overseas Stations, 1869-1897," 40 pp., Sept 1980 (Presented at Fourth Naval History Symposium, US Naval Academy, 26 October 1979, AD A091 316)
- PP 296
Dismukes, Bradford and Petersen, Charles C., "Maritime Factors Affecting Iberian Security," (Factores Maritimos que Afectan la Seguridad Iberica) 14 pp., Oct 1980, AD A092 733
- PP 297 - Classified
- PP 298
Mizrahi, Maurice M., "A Markov Approach to Large Missile Attacks," 31 pp., Jan 1981, AD A096,159
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Jondrow, James M. and Levy, Robert A., "Wage Leadership in Construction," 19 pp., Jan 1981, AD A094 797
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Jondrow, James and Schmidt, Peter,* "On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model," 11 pp., Jan 1981, AD A096 160
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Jondrow, James M. and Levy, Robert A., "The Effect of Imports on Employment Under Rational Expectations," 19 pp., Apr 1981, AD A099 392
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Thomson, James, "The Rarest Commodity in the Coming Resource Wars," 3 pp., Aug 1981 (Published in the Washington Star, April 13, 1981), AD A104 221
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Duffy, Michael K.; Greenwood, Michael J.* and McDowell, John M.,** "A Cross-Sectional Model of Annual Interregional Migration and Employment Growth: Intertemporal Evidence of Structural Change, 1958-1975," 31 pp., Apr 1981, AD A099 393
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Thomson, James, "Dependence, Risk, and Vulnerability," 43 pp., Jun 1981, AD A102 698
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Mizrahi, M.M., "Correspondence Rules and Path Integrals," Jul 1981, Published in "Nuovo Cimento B", Vol. 61 (1981), AD A102 699
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Weinland, Robert G., "An (The?) Explanation of the Soviet Invasion of Afghanistan," 44 pp., May 1981, AD A100 422
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Stanford, Janette M. and Tai Te Wu,* "A Predictive Method for Determining Possible Three-dimensional Foldings of Immunoglobulin Backbones Around Antibody Combining Sites," 19 pp., Jun 1981 (Published in J. theor. Biol. (1981) 88, 421-439, AD A100 423
*Northwestern University, Evanston, IL
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Bowes, Marianne, Brechling, Frank P. R., and Utgoff, Kathleen P. Classen, "An Evaluation of UI Funds," 13 pp., May 1981 (Published in National Commission on Unemployment Compensation's Unemployment Compensation: Studies and Research, Volume 2, July 1980), AD A100 424
- PP 312
Jondrow, James; Bowes, Marianne and Levy, Robert, "The Optimum Speed Limit," 23 pp., May 1981, AD A 100 425
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Roberts, Stephen S., "The U.S. Navy in the 1980s," 36 pp., Jul 1981, AD A 102 696
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Buck, Ralph V., Capt., "Le Catastrophe by any other name....," 4 pp., Jul 1981, AD A102 697
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Roberts, Stephen S., "Western European and NATO Navies, 1980," 20 pp., Aug 1981, AD A104 223
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Roberts, Stephen S., "Superpower Naval Crisis Management in the Mediterranean," 35 pp., Aug 1981, AD A104 222
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Smith, Michael W., "Anti-air warfare Defense of Ships at Sea," 46 pp., Sep 1981 (This talk was delivered at the Naval Warfare System and Technology Conference of the American Institute of Aeronautics and Astronautics in Washington on December 12, 1980; in Boston on January 20, 1981; and in Los Angeles on June 12, 1981.), AD A106 191
- PP 320
Trost, R. P.; Lurie, Philip and Berger, Edward, "A Note on Estimating Continuous Time Decision Models," 15 pp., Sep 1981, AD A106 193
- PP 321
Duffy, Michael K. and Ladman, Jerry R., "The Simultaneous Determination of Income and Employment in United States--Mexico Border Region Economies," 34 pp., Sep 1981
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Warner, John T., "Issues in Navy Manpower Research and Policy: An Economist's Perspective," 66 pp., Dec 1981, AD A110 221
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Bomse, Frederick M., "Generation of Correlated Log-Normal Sequences for the Simulation of Clutter Echoes," 33 pp., Dec 1981.
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Horowitz, Stanley A., "Quantifying Seapower Readiness," 6 pp., Dec 1981 (Published in Defense Management Journal, Vol. 18, No. 2), AD A 110 220
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Roberts, Stephen S., "Western European and NATO Navies, 1981," 27 pp., Jul 1982, AD A118 703
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Hammon, Collin, Capt., USN and Graham, David R., Dr., "Estimation and Analysis of Navy Shipbuilding Program Disruption Costs," 12 pp., Mar 1980, AD A112 514
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Weinland, Robert G., "Northern Waters: Their Strategic Significance," 27 pp., Dec 1980, AD A112 509
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Wengel, Marc, "Applied Mathematicians And Naval Operators," 40 pp., Mar 1982 (Revised), AD A116 598
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Lockman, Robert F., "Alternative Approaches to Attrition Management," 30 pp., Jan 1982, AD A112 510
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Roberts, Stephen S., "The Turkish Straits and the Soviet Navy in the Mediterranean," 15 pp., Mar 1982 (Published in Navy International)
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Jenn, Christopher, "The RDF and Amphibious Warfare," 36 pp., Mar 1982, AD A 113 592
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Lee, Lung-Fei and Trost, Robert P., "Estimation of Some Limited Dependent Variable Models with Application to Housing Demand," 26 pp., Jan 1982. (Published in Journal of Econometrics 3 (1979) 357-382), AD A 112 536
- PP 334
Kenny, Lawrence W., Lee, Lung-Fei, Maddala, G. S., and Trost, R. P., "Returns to College Education: An Investigation of Self-Selection Bias Based on the Project Talent Data," 15 pp., Jan 1982. (Published in International Economic Review, Vol. 20, No. 3, October 1979), AD A112 480
- PP 335
Lee, Lung-Fei, G.S. Maddala, and R. P. Trost, "Asymptotic Covariance Matrices of Two-Stage Probit and Two-Stage Tobit Methods for Simultaneous Equations Models with Selectivity," 13 pp., Jan 1982. (Published in Econometrica, Vol. 48, No. 2 March, 1980), AD A112 483
- PP 336
O'Neill, Thomas, "Mobility Fuels for the Navy," 13 pp., Jan 1982. (Accepted for publication in Naval Institute Proceedings), AD A112 511
- PP 337
Warner, John T. and Goldberg, Matthew S., "The Influence of Non-Pecuniary Factors on Labor Supply," 23 pp., Dec 1981, AD A113 094
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Wilson, Desmond P., "The Persian Gulf and the National Interest," 11 pp., Feb 1982, AD A112 505
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Lurie, Philip, Trost, R. P., and Berger, Edward, "A Method for Analyzing Multiple Spell Duration Data," 34 pp., Feb 1982, AD A112 504
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Trost, Robert P. and Vogel, Robert C., "Prediction with Pooled Cross-Section and Time-Series Data: Two Case Studies," 6 pp., Feb 1982, AD A112 503
- PP 342
Lee, Lung-Fei, Maddala, G. S., and Trost, R. P., "Testing for Structural Change by O-Methods in Switching Simultaneous Equations Models," 5 pp., Feb 1982, AD A112 482
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Goldberg, Matthew S., "Projecting the Navy Enlisted Force Level," 9 pp., Feb 1982, AD A112 484
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Fletcher, Jean, W., "Navy Quality of Life and Reenlistment," 13 pp., Nov 1981, AD A113 095
- PP 345
Utgoff, Kathy and Thaler, Dick, "The Economics of Multi Year Contracting," 47 pp., Mar 1982. (Presented at the 1982 Annual Meeting of the Public Choice Society, San Antonio, Texas, March 5-7, 1982), AD A114 732
- PP 346
Rostker, Bernard, "Selective Service and the All-Volunteer Force," 23 pp., Mar 1982, AD A113 096
- PP 347
McConnell, James, M., "A Possible Counterforce Role for the Typhoon," 24 pp., Mar 1982, AD A116 601
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Jondrow, James, Trost, Robert, "An Empirical Study of Production Inefficiency in the Presence of Errors-in-the-Variables," 14 pp., Feb 1982, AD A113 591

PP 349

W. H. Breckenridge, O. Kim Maimin, "Collisional Intra-multiplet Relaxation of $\text{Cd}(5s5p^3P_{0,1,2})$ by Alkane Hydrocarbons," 7 pp., Jul 1981. (Published in Journal of Chemical Physics, 76(4), 15 Feb 1982), AD A113 093

PP 350

Levin, Marc, "A Method for Increasing the Firepower of Virginia Class Cruisers," 10 pp., Apr 1982. (To be published in U.S. Naval Institute Proceedings), AD A116 602

PP 351

Coutre, S. E.; Stanford, J. M.; Hovis, J. G.; Stevens, P. W.; Wu, T. T., "Possible Three-Dimensional Backbone Folding Around Antibody Combining Site of Immunoglobulin MOPC 167," 18 pp., Apr 1982. (Published in Journal of Theoretical Biology).

PP 352

Barfoot, C. Bernard, "Aggregation of Conditional Absorbing Markov Chains," 7 pp., June 1982 (Presented to the Sixth European Meeting on Cybernetics and Systems Research, held at the University of Vienna, Apr 1982.), AD A116 603

PP 353

Barfoot, C. Bernard, "Some Mathematical Methods for Modeling the Performance of a Distributed Data Base System," 18 pp., June 1982. (Presented to the International Working Conference on Model Realism, held at Bad Honnek, West Germany, Apr 1982.), AD A116 604

PP 354

Hall, John V., "Why the Short-War Scenario is Wrong for Naval Planning," 6 pp., Jun 1982., AD A118 702

PP 356

Cylke, Steven; Goldberg, Matthew S.; Hogan, Paul; Mairs, Lee; "Estimation of the Personal Discount Rate: Evidence from Military Reenlistment Decisions," 19 pp., Apr 1982., AD A122 419

PP 357

Goldberg, Matthew S., "Discrimination, Nepotism, and Long-Run Wage Differentials," 13 pp., Sep 1982. (Published in Quarterly Journal of Economics, May 1982.).

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