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RESEARCH MEMORANDUM

ESTIMATION OF MPN OBLIGATIONS

David M. Rodney
Mark B. Geis
Jerry A. Hammer

A Division of

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1. This research memorandum represents the final documentation of a CNA project request by the Assistant Deputy Chief of Naval Operations (Manpower, Personnel and Training) (OP-01). It documents analyses of methods that provide Navy management a top-level monitoring capability with respect to the execution of the MPN appropriation. In particular, analysis is focused on the identification of leading indicators of MPN obligations that provide accurate forecasts of fiscal year obligations within a few months of the fiscal year's start.

The study demonstrates that succinct and accurate estimation methods may be applied to only some of the so called "strength-related" pay categories within the MPN account. In particular, a knowledge of strength plans provides reasonably accurate estimates of obligations for basic pay, retired pay accrual, basic allowance for quarters, and FICA for both officers and enlisted personnel, and officer basic allowance for subsistence.

2. Enclosure (1) is forwarded as a matter of possible interest.


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ABSTRACT

This research memorandum describes an analysis of methods that will enable OP-01 to monitor more closely the execution of the MPN appropriation. In particular, the analysis is concerned with the identification of leading indicators of MPN obligations that provide accurate forecasts of fiscal year obligations within a few months of the fiscal year's start. The study demonstrates that succinct and accurate estimation techniques may be applied to basic pay, retired pay accrual, basic allowance for quarters, FICA, and officer basic allowance for subsistence. Other pay categories exhibit too much irregularity to be amenable to such forecasting methods. The analysis exhibits the margins of error that apply to the forecasts and are inherent in the Navy's information systems.



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EXECUTIVE SUMMARY

Management of the execution of the Military Personnel Navy (MPN) appropriation is a complex and difficult task. Navy managers attempt to precisely control the expenditures of a \$17 billion account for which it is illegal to obligate more than Congress authorizes. The ability to accomplish this task is directly related to the timeliness and accuracy of data describing current-year MPN expenditures. It is usually uncertain until well into a fiscal year whether execution is on track. At that time the Navy may have to take action to bring expenditures into line with appropriation levels. The options available to Navy managers for the control of MPN expenditures diminish as the fiscal year progresses. Moreover, the small number of options available during the latter months in a fiscal year tend to be disruptive to Navy personnel management. The earlier in a fiscal year the Navy can be aware that MPN execution is awry, the more efficiently and easily corrective actions can be taken.

This report describes an analysis of methods that will enable OP-01 to monitor more closely the execution of the MPN appropriation. In particular, the analysis is concerned with the identification of leading indicators of MPN obligations that provide accurate forecasts of fiscal year obligations within a few months of the fiscal year's start. The objective of the study has been to provide Navy management a top-level monitoring capability with regards to the MPN account. The management of line items within the MPN appropriation is carried out by several offices within OP-01 and NMPC. The Navy uses a variety of large and complex models in managing the various items in the MPN account. For example, OP-136 employs several models to manage just the SRB appropriation. The results of this analysis in no way substitute for such detailed effort. Instead, the analysis has been confined to methods that could be implemented on a microcomputer, and preferably on a spreadsheet.

MPN execution may differ from planned levels for at least two reasons: discrepancies may arise between obligations and expenditures, and the strength plans underlying the MPN appropriation may differ from the actual inventory that evolves. The former situation is mostly caused by accounting problems and has been the subject of much study. This study addresses the latter situation where strength plans prove to be inaccurate.

The study demonstrates that succinct and accurate estimation methods may be applied to only some of the so called "strength-related" pay categories within the MPN account. In particular, it is possible to obtain reasonably accurate estimates of a variety of pay categories based upon knowledge of strength plans. The pay categories that are open to such an estimation process are basic pay, retired pay accrual (RPA), basic allowance for quarters (BAQ), FICA, and officer basic allowance for subsistence (BAS). Other pay categories exhibit too much irregularity to be amenable to such forecasting methods.

The value of the above estimation techniques is magnified by the size of the pay categories that are addressed. Basic pay, RPA, BAQ, and FICA account for more than 82 percent of total

MPN obligations. Consequently, the majority of the MPN account is amenable to succinct analysis.

From both practical and statistical standpoints, the estimation methods are as accurate as one can expect to obtain. The estimation techniques provide confidence intervals that are frequently less than 1 percent of obligations. For example, in a three-month forecast of enlisted basic pay, one has 95 percent confidence that the forecast will be within \$16 million of the actual value. Three months of enlisted basic pay obligations amount to approximately \$1.5 billion. Due to the complexity of the Navy's information systems, one could not expect any greater precision.

It is illegal for the Navy to overexpend authorizations. Consequently, strength and budget plans should err on the side of caution. It makes more sense to plan for a marginal under-obligation of authorized funds and make adjustments as the year progresses than to plan to spend every dime that is authorized. Navy managers may save money by varying the timing of losses, gains, and promotions. In previous years, it was a common practice for strength plans to contain some slack in planned promotions, accessions, and losses, which could be the source of money savings if necessary. With recent budget constraints, this flexibility seems to be drying up. Unfortunately, this takes away required leeway and forces undesirable management decisions if events do not precisely follow plans.

The study led to the opinion that the Navy could take at least two actions to better manage the MPN account. The first option concerns the somewhat fragmented manner in which Navy personnel managers operate. The management of the MPN account requires the knowledge and inputs of many organizations within OP-01 and NMPC. Historically, these organizations have operated independently and have come together only once a month in order to present a briefing to the Chief of Naval Personnel. The recent organizational changes within OP-13 geared to instituting an office responsible for coordinating the management of MPN account execution, are to be applauded. Its implementation should facilitate gathering the disparate information needed in this area.

In addition, the Navy should consider the adequacy of the information that is being provided to managers of the MPN account. For example, estimation of VHA obligations is inhibited by a lack of software that would compute such obligations from a geographical distribution of personnel and VHA rate tables. One suspects that ADP support could be improved in a number of areas. Because this area cuts across many organizations, the establishment of a coordinating function within OP-13 might help bring such problems to light.

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INTRODUCTION

Managing the execution of the Military Personnel Navy (MPN) appropriation is complex and difficult. Navy managers attempt to precisely control the expenditures of a \$17 billion account for which it is illegal to obligate more than Congress authorizes. The ability to accomplish this task is directly related to the timeliness and accuracy of data describing current-year MPN expenditures. It is usually uncertain until well into a fiscal year whether execution is on track. At that time the Navy may have to take action to bring expenditures into line with appropriation levels. The options available to Navy managers for the control of MPN expenditures diminish as the fiscal year progresses. Moreover, the small number of options available during the latter months in a fiscal year tend to be disruptive to Navy personnel management. The earlier in a fiscal year the Navy can be aware that MPN execution is awry, the more efficiently and easily corrective actions can be taken.

This report describes an analysis of methods that will enable OP-01 to monitor more closely the execution of the MPN appropriation. In particular, the analysis is concerned with the identification of leading indicators of MPN obligations that provide accurate forecasts of fiscal obligations within a few months of the fiscal year's start. The objective of the study has been to provide Navy management a top-level monitoring capability with regards to the MPN account. The management of line items within the MPN appropriation is carried out by several offices within OP-01 and NMPC. The Navy uses many large and complex models in managing the various items in the MPN account. For example, OP-136 uses several models to manage just the SRB appropriation. The results of this analysis are in no way a substitute for such detailed effort. Instead, the analysis has been limited to methods that could be implemented on a microcomputer, and preferably on a spreadsheet.

Execution of the MPN appropriation may differ from planned levels for at least two reasons: discrepancies may arise between obligations and expenditures, and the strength plans underlying the MPN appropriation may differ from the actual inventory that evolves. The former situation is mostly caused by accounting problems and has been the subject of much study. Indeed, recent work by the Navy Personnel Research and Development Center (NPRDC) has provided the Naval Military Personnel Command (NMPC) with a means of projecting and accounting for differences between obligations and expenditures [1]. This study addresses the latter situation, in which strength plans prove to be inaccurate.

The MPN appropriation provides for the many costs associated with paying and moving Navy personnel. It is a large item in the Navy's total budget and is constantly subject to review by the Navy, the Office of the Secretary of Defense (OSD), and Congress. In particular, in a time of tight budgets, attempts to save money by cutting personnel costs are frequent. The level of MPN obligations depends upon many factors, and small changes in any of these can have a significant impact on obligations. For example, a small change in continuation rates could lead to obligations varying by millions of dollars. This research memorandum demonstrates the

importance of having accurate projections of such factors as continuation rates in the planning process. It also describes a capability to compute the fiscal impact of deviations from planned levels.

The MPN account differs from the majority of the Navy's budget in a fundamental way. Most of the Navy's budget is controlled by contracts that prohibit spending money without the explicit authorization of the government. Personnel costs are different. Navy personnel are entitled to be paid regardless of authorization limits. The many personnel actions that directly bear on MPN obligations (e.g., recruiting, promotions, reenlistments) are managed at a macro level, where broad guidelines are set to ensure compliance with appropriation limits. However, the attained levels of these parameters vary greatly as one moves around the Navy. This situation is inevitable, given the nature of our volunteer force. Consequently, obligation levels cannot be exactly prescribed. Given the illegality of exceeding appropriation levels, a prudent manager of the MPN account might allow for a margin of error in budgets, thus minimizing the possibility of overspending the account. However, such an approach means that dollars may go unspent at the end of the fiscal year. These unspent dollars will be a direct consequence of not having authorized levels of personnel in the Navy, which is clearly not satisfactory. Thus, in many ways, the management of the MPN account involves deciding how close one can plan to meet authorized personnel levels without risking overexpenditures. The accuracy of pertinent forecasts is obviously a major factor in this process. This research memorandum addresses these issues and may help the Navy in managing the execution of the MPN account.

The report begins with a review of the MPN account, describing trends plus its size and content. The next section analyzes methods of obtaining forecasts of items within the MPN account. The MPN account may be divided into two parts: items that are strength related (e.g., basic pay and social security tax, (i.e., FICA)) and other budget items (e.g., incentive pays and PCS costs). For a variety of reasons the primary focus of the analysis is on the strength-related items. Strength-related obligations amount to more than 80 percent of the MPN account and are comparatively easy to predict, being a direct consequence of inventories. Non-strength-related obligations are harder to predict, requiring strength-related data plus information relating to the precise budget item under consideration. For example, overseas station allowance obligations are based not only on numbers of personnel overseas but also on currency exchange rates. In addition, non-strength-related obligations are much more amenable to being rapidly constrained by Navy managers and, as such, tend to be used as a means of keeping overall MPN obligations within appropriation levels. Consequently, non-strength-related obligation levels are often a reaction to a policy action taken to correct budgeting problems, thus making them difficult to predict.

The report continues with a review of the MPN appropriation for FY 1987. The execution of the 1987 appropriation was fraught with problems, and the Navy had difficulty in keeping expenditures within obligation levels. A variety of strength plans for the 1987 budget are reviewed, and conclusions are reached regarding some causes of the difficulties. The next section contains a similar analysis of the FY 1988 MPN account. The report finally offers conclusions and recommendations.

OVERVIEW OF MPN ACCOUNT

The following description of the MPN account should enable one to view the relative and absolute magnitude of the various categories of obligations. A useful starting point is the size of the account and corresponding inventory sizes and how they have varied in recent years. Table 1 contains the relevant data.

Table 1. Historical inventories and obligations

Fiscal year	MPN obligations (\$ millions)	End strength	
		Officer	Enlisted
1983	10,916	68,494	484,568
1984	11,522	68,856	491,288
1985	16,112	70,657	495,444
1986	16,936	72,051	504,389
1987	17,794	72,051	510,026

The large increase in MPN obligations in 1985 was caused by the addition of retirement accrual to the MPN account. The following tables, which describe details of obligations in 1987, reveal the composition of the MPN account. Table 2 shows the division of obligations into major categories.

Table 2. FY 1987 obligations

Budget category	(\$ millions)	Percentage of obligation
Officer pay and allowances	4,156	23.5
Enlisted pay and allowances	12,157	68.8
Cadets/midshipmen pay and allowances	36	0.2
Enlisted subsistence	758	4.3
Permanent change-of-station costs	517	2.9
Other	45	0.3
Total	17,669	
Reimbursables	124	

The categories in table 2 come from official budget submissions. In these documents, officer subsistence obligations are part of officer pay and allowances, whereas they are displayed separately for enlisted subsistence. The category "Other" covers such items as unemployment compensation and the cost of apprehending deserters. Finally, total obligations are partially offset by amounts that are reimbursable from other government accounts. The magnitude of reimbursables is fairly stable, and the 1987 level was representative. The pay and allowance categories can be further subdivided as shown in tables 3 and 4.

Table 3. FY 1987 officer pay and allowances

Category subdivision	(\$ millions)	Percentage of obligation
Basic pay	2,098	50.5
Retired pay accrual	1,099	26.4
Basic allowance for quarters	307	7.4
Variable housing allowance	118	2.8
Social security tax	149	3.6
Basic allowance for subsistence	97	2.3
Incentive pay	95	2.3
Special pay	117	2.8
Other	76	1.8
Total	4,156	

Table 4. FY 1987 enlisted pay and allowances

Category subdivision	(\$ millions)	Percentage of obligation
Basic pay	6,243	51.4
Retired pay accrual	3,265	26.9
Basic allowance for quarters	899	7.4
Variable housing allowance	298	2.5
Social security tax	443	3.6
Incentive pay	93	0.8
Special pay	259	2.1
Special duty assignment pay	51	0.4
Enlistment bonus	12	0.1
Reenlistment bonus	233	1.9
Other	361	3.0
Total	12,157	

The category "Other" in tables 3 and 4 includes such items as overseas station allowances and family separation allowances. It can be seen from these two tables that a few of the pay categories account for the preponderance of the obligations. In particular, basic pay and retired pay accrual (RPA) account for almost 78 percent of pay and allowance obligations and 72 percent of the entire MPN account. This observation is central to the management of the MPN account. If pay and allowance obligations are well managed, then the MPN account, as a whole, will probably be in good shape. In addition, various items in the MPN account will be directly proportional to basic pay obligations. For example, social security payments are a fixed percentage of basic pay. Consequently, accurate management of basic pay will have a "multiplier effect" on the overall management of the MPN appropriation.

MODELS FOR MPN OBLIGATIONS

INTRODUCTION

The efforts undertaken to obtain forecasts of MPN obligations are described in this section. The analysis was guided by the aforementioned considerations concerning a few MPN line items being responsible for a majority of obligations. The line items were divided into "strength-related" and "non-strength-related" groups, in the same fashion as the monthly MPN briefing to OP-01. The strength-related items are displayed in table 5.

Table 5. MPN strength-related items

Cost category	Officer	Enlisted
Basic pay	*	*
Retired pay accrual	*	*
Basic allowance for quarters	*	*
Variable housing allowance	*	*
Social security tax	*	*
Subsistence allowance	*	-

Enlisted subsistence is not part of these strength-related items. This follows the anomaly with the categorization of enlisted subsistence, as noted in the previous section. The designation of an obligation as being related to strength connotes that it should be determined by inventory or, possibly, be proportional to basic pay. The analysis of these strength-related items focused upon a determination of whether such suppositions are justified, and if so, forecasting models were estimated. Enlisted subsistence was included in the analysis in order to be consistent between officers and enlisted personnel. Non-strength-related items were also analyzed with an aim towards obtaining estimating techniques that could be implemented on a microcomputer.

STRENGTH-RELATED OBLIGATIONS

Historical Inventories

The analysis of strength-related obligations was based upon monthly data for FY 1983 to FY 1987. In theory, estimating such items as basic pay obligations should be a very precise, if not deterministic, process if one has accurate knowledge of inventories. So, the analysis starts with a look at inventories. Figures 1 and 2 exhibit monthly endstrengths for officers and enlisted personnel, respectively. The figures display the inventory growth that occurred from 1983 to 1987. The distribution of the inventory by pay grade and length of service is required before pay

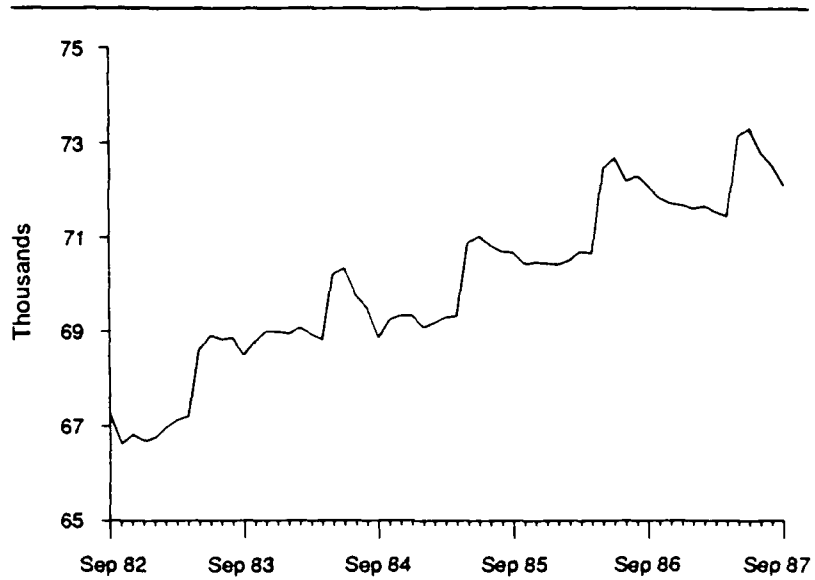


Figure 1. Officer end strength

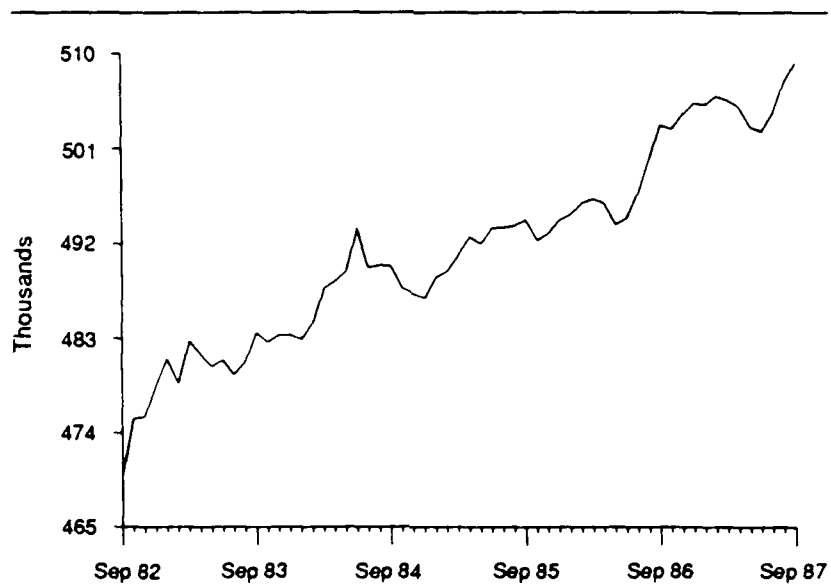


Figure 2. Enlisted end strength

obligations can be completed. These data are rather voluminous and so they are displayed separately in appendix A. Tables 6 and 7 summarize that appendix.

Table 6. Officer pay grade distributions

Pay grade	Percent					
	Sep 82	Sep 83	Sep 84	Sep 85	Sep 86	Sep 87
O-7 +	0.37	0.36	0.37	0.35	0.35	0.35
O-6	5.66	5.48	5.38	5.24	5.15	5.10
O-5	11.52	11.20	11.08	10.99	10.78	10.83
O-4	19.23	18.65	18.67	18.60	18.57	18.22
O-3	28.28	29.47	30.86	31.20	31.13	32.91
O-2	15.26	15.45	15.37	14.83	13.44	13.11
O-1	15.34	14.95	13.80	14.32	16.23	15.36
W-4	0.68	0.88	1.37	1.53	1.56	1.44
W-3	1.85	1.89	1.42	1.19	1.12	1.19
W-2	1.78	1.67	1.69	1.75	1.66	1.50

Table 7. Enlisted pay grade distributions

Pay grade	Percent					
	Sep 82	Sep 83	Sep 84	Sep 85	Sep 86	Sep 87
E-9	0.78	0.78	0.83	0.91	0.96	0.91
E-8	1.80	1.85	1.81	1.98	1.99	2.04
E-7	6.42	6.28	6.27	6.65	6.62	6.63
E-6	13.82	13.97	14.94	15.81	15.69	15.88
E-5	18.70	19.78	19.95	21.02	20.31	20.06
E-4	21.68	22.76	21.55	21.16	21.40	21.16
E-3	18.82	18.26	19.74	16.94	16.67	16.99
E-2	9.90	9.16	7.63	8.18	8.44	8.99
E-1	8.09	7.15	7.29	7.36	7.94	7.34

Evidently, pay grade distribution has changed in numerous ways between 1983 and 1987. One can see an increased percentage of lieutenants (O-3s) at the expense of other grades, and an increased percentage of senior warrant officers (W-4s) while the percentage of W-3s has declined. With regard to enlisted personnel, one can see that the inventory has steadily increased

in seniority. More detailed inventory distribution data are used during the estimation process, as will be described below.

Precise computation of pay obligations requires average onboard counts. However, historical inventory data were used for two reasons. First, average monthly strength counts were not readily available from the enlisted strength planners. Second, the data were used to build models for the estimation of pay obligations. These models will be used to forecast obligations that arise from strength plans. Strength plans are based upon monthly end strengths. So, in order to be consistent with the forecast input data, it was appropriate to use end strength as opposed to average strength data.

Correlation of Cost Categories

The analysis begins with an investigation of the correlation between the various "strength-related" pay categories and inventories for both officers and enlisted personnel. The pay categories are listed in table 5, above, and include basic pay, RPA, basic allowance for quarters (BAQ), variable housing allowance (VHA), FICA, and basic allowance for subsistence (BAS). Monthly obligations for these pay items are displayed in figures 3 through 14. The actual data are tabulated in appendix B.

Figure 4 reflects the fact that retired pay accrual became part of the MPN appropriation in FY 1985. Figure 14 displays data for enlisted BAS and subsistence in kind (SIK). The complementary nature of these allowances makes it natural to consider them jointly. All of the data in figures 3 through 8 exhibit growth over time. However, this is to be expected from pay raises. Closer examination reveals substantial variation in the data. For example, basic pay, BAQ, and BAS data exhibit large fluctuations near the end of FY 1984. The FICA, RPA, and VHA data also exhibit large variations at certain points in time. Evidently, MPN obligations do not maintain fairly constant values from one month to the next. Accurate models of obligations will need to capture these monthly variations. All the models described below have the following underlying idea: strength-related obligations may be estimated from knowledge of either inventories or basic pay. For example, one model estimated basic pay obligations directly from inventory data. RPA obligations are estimated to be a fixed percentage of basic pay, following budget guidelines. The correlation between the various strength-related pay items and inventory provides an initial indication of the probable success of this approach. Tables 8 and 9 exhibit various correlation coefficients.

The correlation between the different variables in tables 8 and 9 is substantial. However, the independent variation between the different officer pay items and strength is still significant.

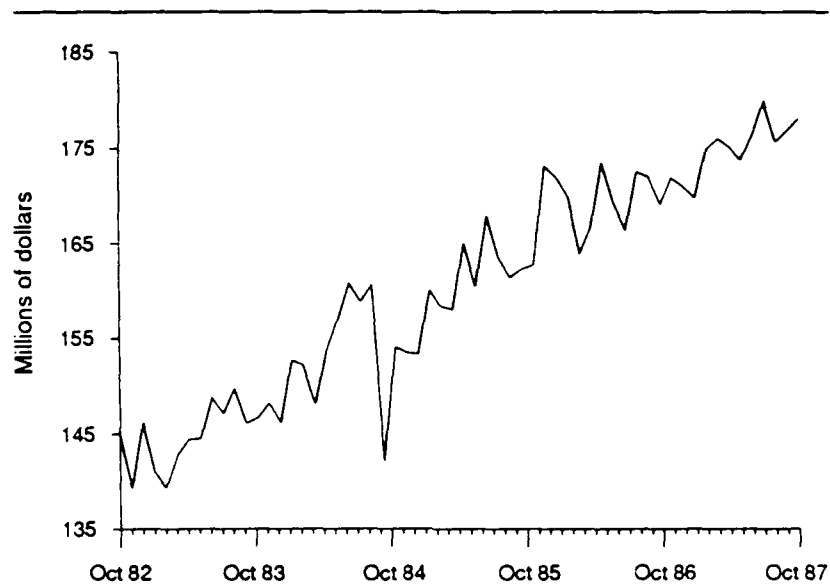


Figure 3. Officer basic pay obligations

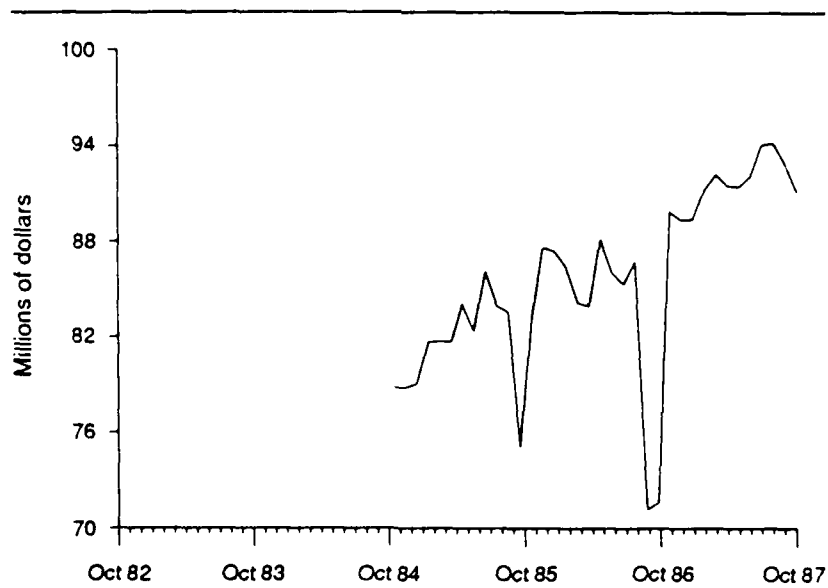


Figure 4. Officer RPA obligations

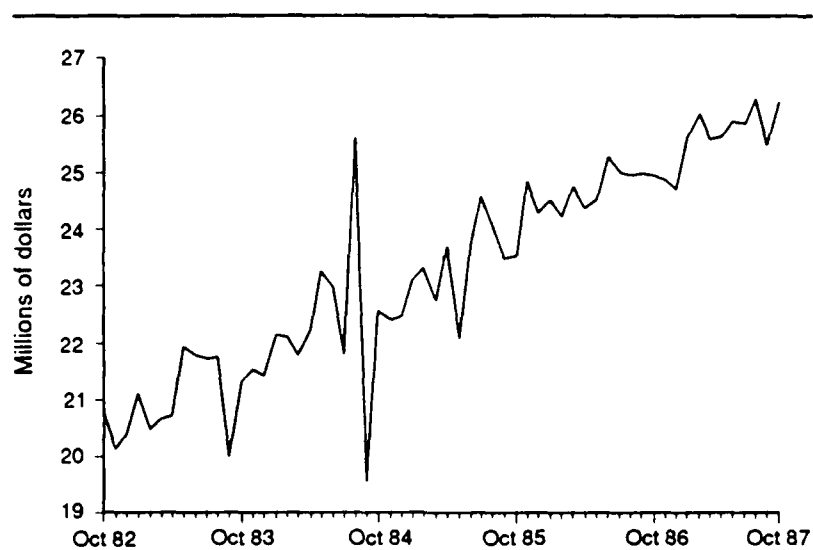


Figure 5. Officer BAQ obligations

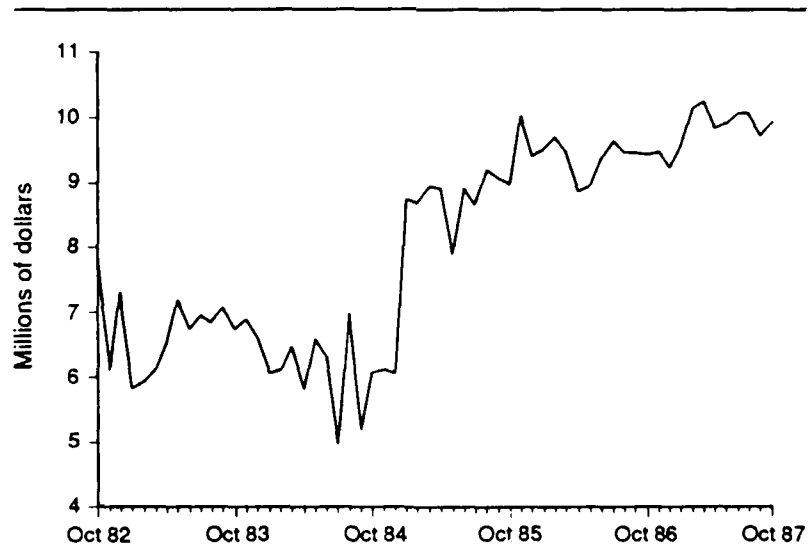


Figure 6. Officer VHA obligations

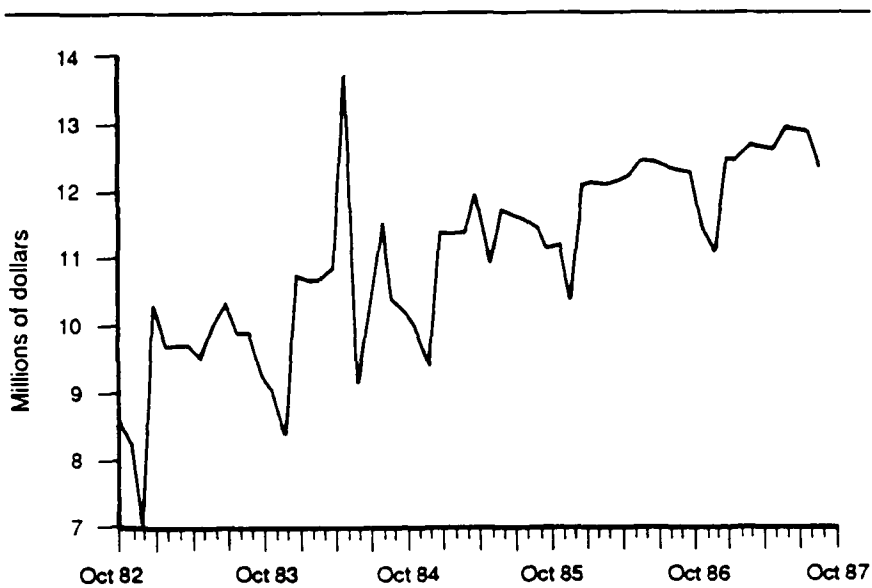


Figure 7. Officer FICA obligations

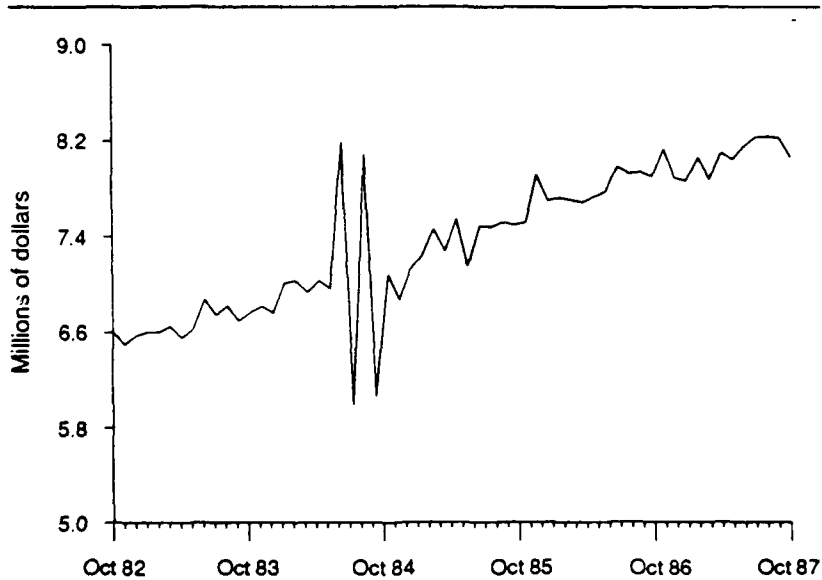


Figure 8. Officer BAS obligations

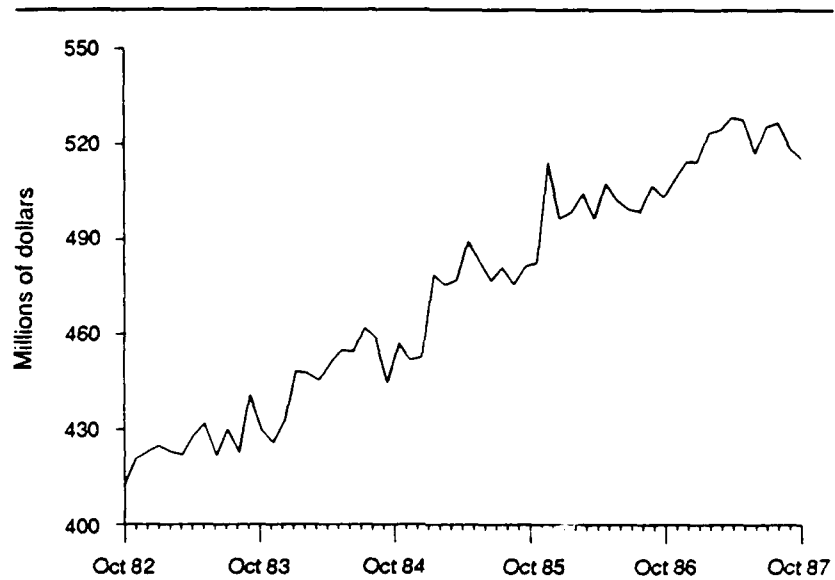


Figure 9. Enlisted basic pay obligations

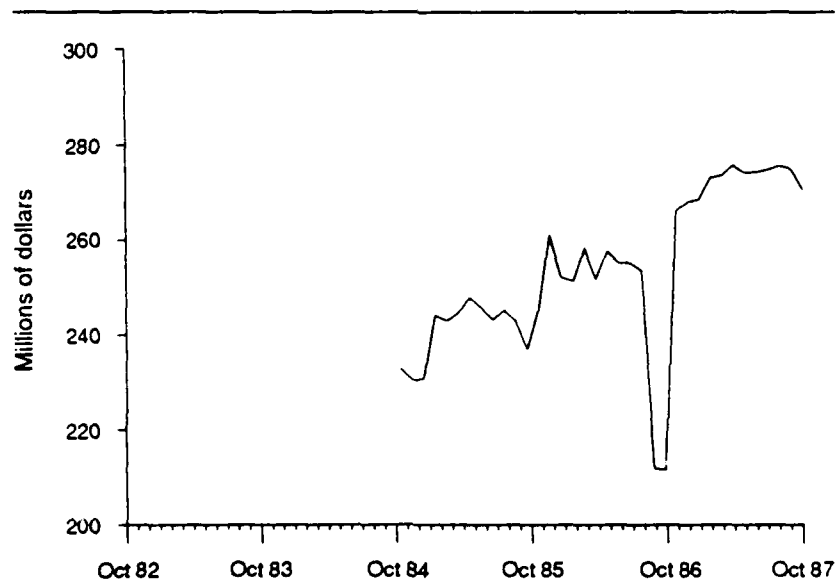


Figure 10. Enlisted RPA obligations

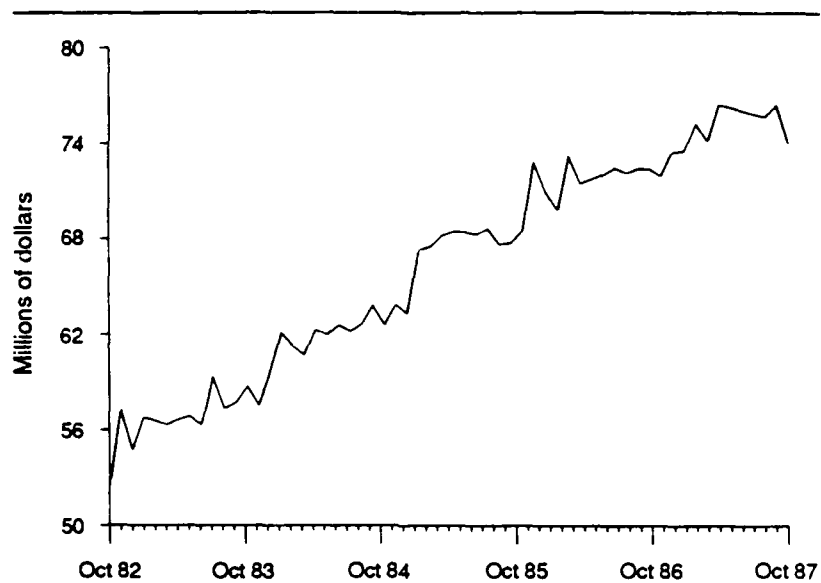


Figure 11. Enlisted BAQ obligations

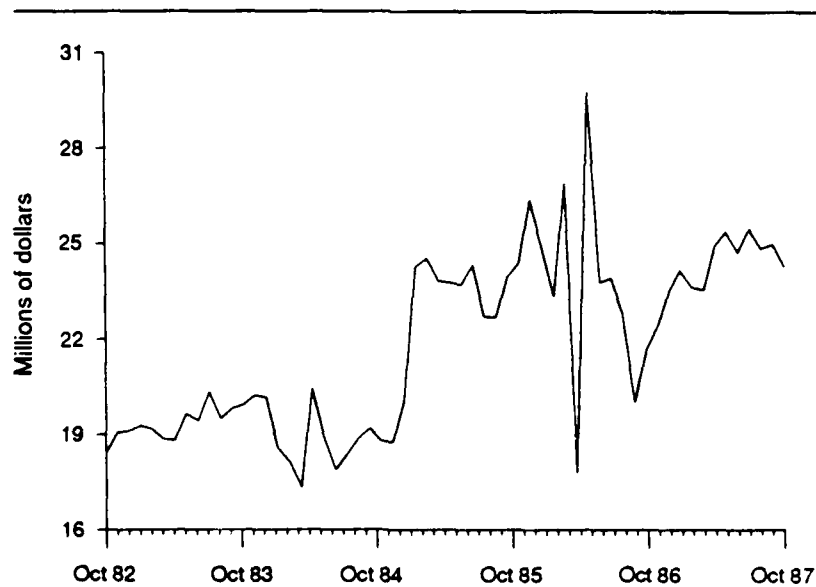


Figure 12. Enlisted VHA obligations

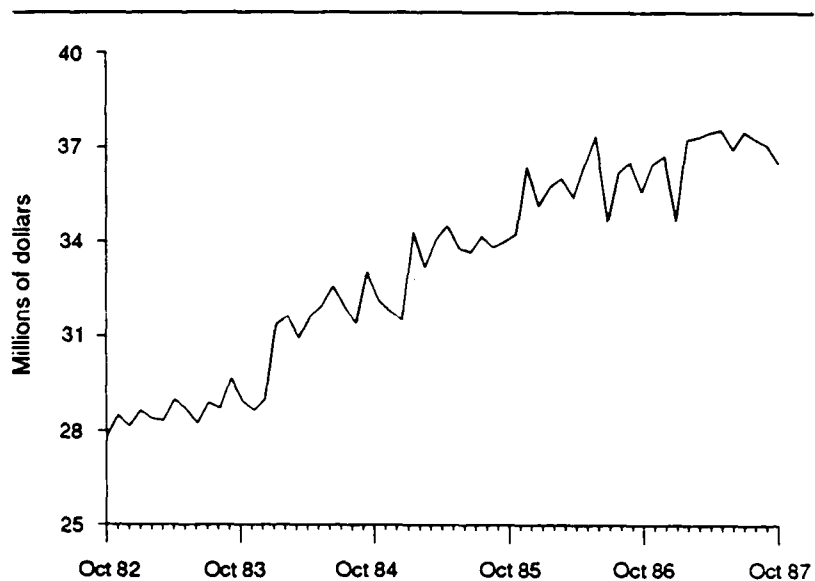


Figure 13. Enlisted FICA obligations

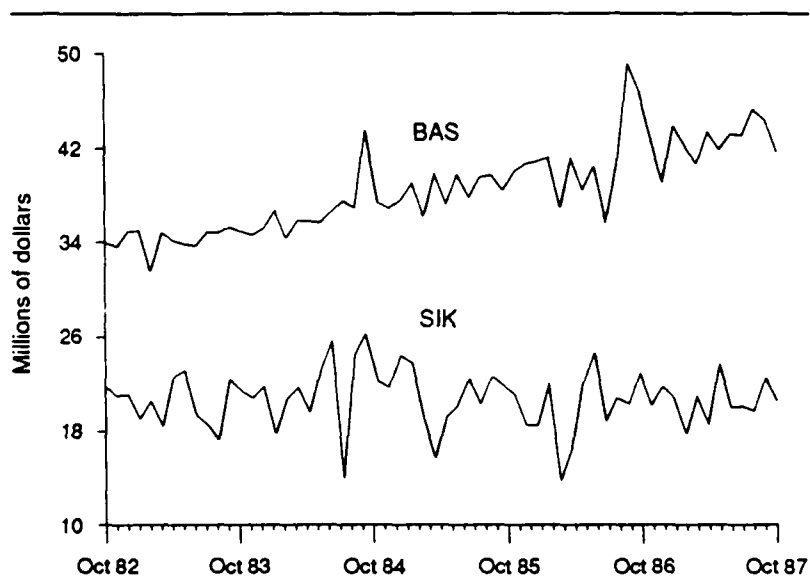


Figure 14. Enlisted BAS/SIK obligations

More detailed analysis is required in order to explain obligations with an acceptable degree of accuracy,¹ and this follows.

Table 8. Correlation of officer strength and obligations

	Basic pay	RPA	BAQ	VHA	BAS	FICA
Officer strength	.92	.49	.89	.77	.85	.80
Basic Pay		.69	.95	.86	.91	.81
RPA			.65	.53	.63	.49
BAQ				.85	.94	.83
VHA					.84	.71
BAS						.74

Table 9. Correlation of enlisted strength and obligations

	Basic pay	RPA	BAQ	VHA	BAS	SIK	FICA
Enlisted strength	.84	.79	.83	.59	.73	-.02	.82
Basic pay		.90	.99	.78	.82	-.11	.98
RPA			.89	.77	.61	-.13	.88
BAQ				.78	.83	-.10	.98
VHA					.51	-.13	.75
BAS						.42	.83
SIK							-.05

Chronology of Pay Raises

Pay raises, changes in rates for RPA and FICA, etc., have not been considered thus far in the analysis. When that information is included, much of the variation in obligation levels is explained. Changes in FY 1983 compensation during FY 1983 to FY 1987 are summarized below. Table 10 exhibits basic pay raises that occurred during that time. The same raises occurred in BAS (and SIK) rates.

1. An acceptable level of accuracy is hard to define. From a statistical viewpoint, being able to forecast obligations to within 1 percent seems accurate. However, 1 percent of \$17 billion is a large sum, and the Navy needs to manage the MPN account with a tolerance of error considerably smaller than \$170 million. The accuracy of forecasting methods and its implications on MPN appropriation management are discussed later in this report.

Table 10. Basic pay and subsistence raises

Date of raise	Pay raise (percent)
January 1984	4
January 1985	4
October 1985	3
January 1987	3

Retired pay accrual is computed as a certain percentage of basic pay. The rates that applied during 1983 to 1987 are shown in table 11.

Table 11. Retired pay accrual rates

Effective dates	RPA rate (percent)
Oct 82-Sep 84	None
Oct 84-Jul 86	50.7
Aug 86-Sep 86	42.0
Oct 86-Sep 87	52.2

Changes in FICA have followed federal guidelines and are displayed in table 12.

Table 12. FICA rates

Calendar year	FICA rate (percent)	FICA cap (dollars)
1982	6.7	32,400
1983	6.7	35,700
1984	7.0	37,800
1985	7.05	39,600
1986	7.15	42,000
1987	7.15	43,800

BAQ rates vary by pay grade and according to whether the personnel have dependents. With the exception of January 1985, percentage changes in BAQ have been invariant across pay grades and dependent status (see table 13).

Table 13. BAQ raises

Date of raise	BAQ raise (percent)
January 1984	4
January 1985	*
October 1985	3
January 1987	3

Except for the January 1985 raise, all BAQ increases have been the same as for basic pay. The January 1985 raise for officers varied across pay grades and averaged approximately 2.3 percent. The January 1985 BAQ raise for enlisted personnel was more complex, with different raises occurring across pay grades and according to whether or not the personnel had dependents. The BAQ rate for enlisted personnel without dependents increased, on average, by approximately 8.2 percent, while the rate for enlisted personnel with dependents increased, on average, by approximately 5.7 percent.

Changes in VHA rates are discussed more fully in the next section, which provides case-by-case analyses of the several MPN line items.

ESTIMATION OF OFFICER STRENGTH-RELATED OBLIGATIONS

Basic Pay

Basic pay is the largest MPN cost item and should be amenable to accurate estimation, given knowledge of inventories. A model is built that multiplies inventories by pay tables in a canonical manner to obtain estimates of basic pay obligations. Since all personnel are paid according to their pay grade and length of service, it is necessary to have pay-grade-by-length-of-service distributions of officer inventories. CNA obtains extracts of the Officer Master File every six months. These files were processed to produce the required distributions. These distributions were used in conjunction with the FY 1983 pay table, which led to average-pay-by-pay-grade data as displayed in table 14. Showing average pay with regard to a fixed pay table provides insight into the fiscal impact of any changes in force seniority: the variations in table 14 are due solely to fluctuations in force seniority. One may translate the data in table 14 to

the average pay rates actually experienced by inflating the data by the pay raises shown in table 10.

Table 14. Officer average monthly basic pay (FY 1983 pay table)

Month	O-7+	O-6	O-5	O-4	O-3	O-2	O-1	W-4	W-3	W-2
Mar 1982	4,674 ^a	3,670	2,921	2,418	1,996	1,590	1,169	2,356	1,966	2,086
Sep 1982	4,674	3,685	2,933	2,421	2,011	1,600	1,163	2,361	1,970	2,096
Mar 1983	4,674	3,684	2,925	2,416	1,993	1,590	1,167	2,348	1,964	2,088
Sep 1983	4,674	3,695	2,926	2,416	1,999	1,592	1,164	2,353	1,974	2,093
Mar 1984	4,674	3,691	2,922	2,414	1,997	1,600	1,160	2,360	1,964	2,096
Sep 1984	4,674	3,704	2,934	2,418	2,006	1,600	1,169	2,354	1,970	2,116
Mar 1985	4,674	3,695	2,930	2,417	2,001	1,592	1,160	2,350	1,966	2,110
Sep 1985	4,674	3,696	2,946	2,423	2,012	1,595	1,158	2,364	1,973	2,110
Mar 1986	4,674	3,687	2,945	2,427	2,008	1,588	1,153	2,363	1,972	2,102
Sep 1986	4,674	3,697	2,959	2,447	2,019	1,604	1,160	2,375	1,984	2,100
Mar 1987	4,674	3,693	2,961	2,444	2,015	1,584	1,155	2,381	1,985	2,101
Sep 1987	4,674	3,691	2,972	2,460	2,025	1,578	1,161	2,380	1,984	2,113

a. Distributions of flag-rank officers by pay grade were not available. Therefore, average pay was estimated to be the average of pay for O-7s and more senior admirals. This inaccuracy has an insignificant effect on the estimation process due to the small number of flag-rank officers.

Table 14 exhibits frequent changes in a pay grade's average pay, with most of the pay grades showing growth (caused by growth in seniority within a pay grade). Taking a weighted average across pay grades of the data in table 14 gives the average basic pay of an officer. This information is displayed in figure 15. (Figure 15 is not really required for the study at hand. However, it is of independent interest and displays the cost of any "aging" of the officer community that may have occurred in recent years.)

Table 14 displays average basic pay, based on an FY 1983 pay table, at fixed points in time—the last days in March and September for 1982 to 1987. The analysis requires data on average pay during a month for each month during FY 1983 to FY 1987. Unfortunately, monthly data were not available. Table 14 was used to estimate the required information in three steps. Initially, the data in table 14 were escalated by the pay raises that occurred during fiscal years 1983 to 1987. Then, the resulting data were interpolated to provide an estimate of average pay at the end of each month. Finally, the average of successive end-of-month estimates was computed as a proxy for average pay during the intervening month. In this fashion, estimates for average officer basic pay, by pay grade, for each month during FY 1983 to FY 1987 were obtained.

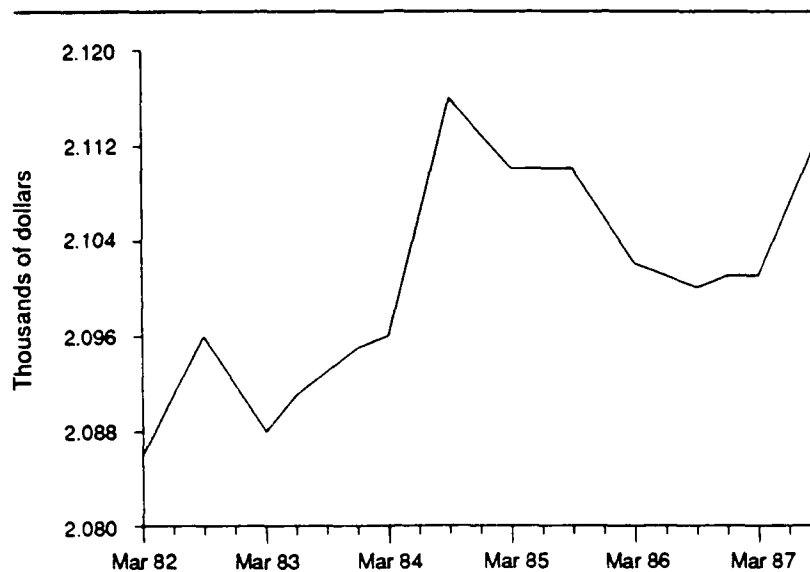


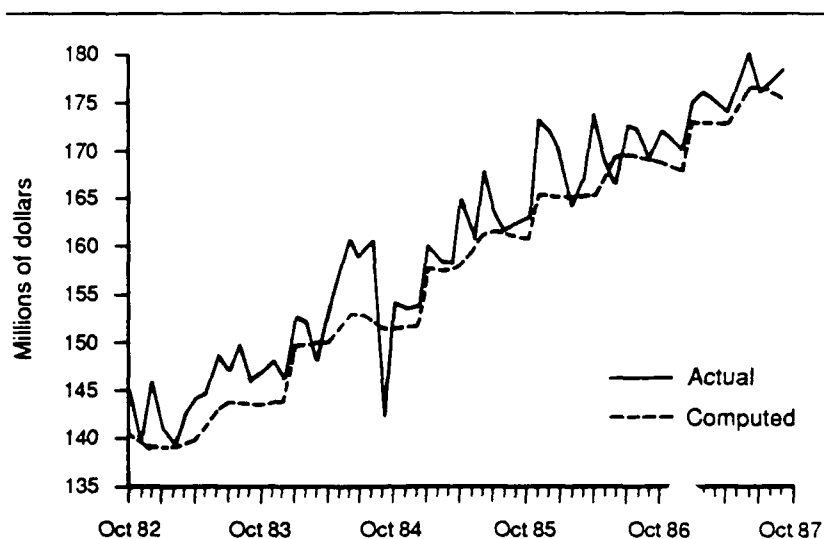
Figure 15. Officer average basic pay (based on FY 1983 pay table)

Next, average basic pay data were multiplied by analogous information on average strength to provide an initial estimate of basic pay obligations. Because the strength data were end-strength counts, it was again necessary to take the average of successive observations to provide average monthly strength estimates. After summing across pay grades, the computed estimate of total officer basic pay obligations was compared with obligations as reported by NMPC-7 and displayed in table B-1 of appendix B. The comparison, graphically displayed in figure 16, shows that the estimate is marginally but consistently less than actual obligations. Possible causes of inaccuracy in the estimation process are several: the estimation of average monthly pay and inventories; problems in the data-reporting systems; and the existence of reimbursable monies in the MPN account.

To correct for these errors, an adjustment factor was computed using regression techniques. In detail, actual basic pay obligations were regressed upon the computed basic pay data using ordinary-least-squares estimation. The regression line was constrained to pass through the origin. Table 15 lists pertinent statistics.

That table demonstrates that a factor of 1.017 provides an excellent adjustment to the initial computations in order to provide a more accurate estimate of officer basic pay. The accuracy of the adjusted data can be seen in figures 17 and 18. Figure 17 shows monthly estimation errors, whereas figure 18 displays cumulative fiscal year errors. The monthly errors (root mean square error = \$3 million) need to be considered in the context of monthly obligations of approximately \$150 million (i.e., errors around 2 percent). Figure 18 shows that the relative size of the errors shrinks in the cumulative fiscal year data, where one is considering annual obligations of approximately \$1.8 billion. The accuracy of the estimates is more precisely displayed by consider-

ing confidence intervals around the predictions (see table 16). (Reference [2], pp. 134-135, contains technical details on the prediction of confidence intervals. In theory, the size of the confidence interval varies with the size of the prediction. In practice, given the relative stability of basic pay obligations, the confidence intervals can be considered to be independent of the prediction.)



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Figure 16. Officer basic pay obligations (actual vs. computed)

Table 15. Regression statistics for officer basic pay estimation

Regression coefficient	=	1.017
Standard error of coefficient	=	.002
t-statistic	=	413.9
R-square	=	.94
Root mean square error	=	\$3 million
Coefficient of variation	=	1.88
Degrees of freedom	=	59
Durbin-Watson statistic	=	2.08

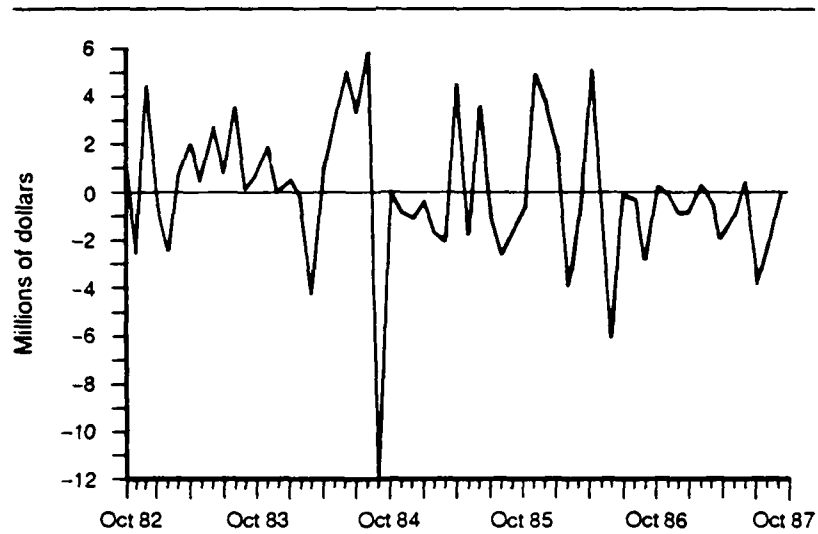


Figure 17. Officer basic pay estimation (actual minus predicted)

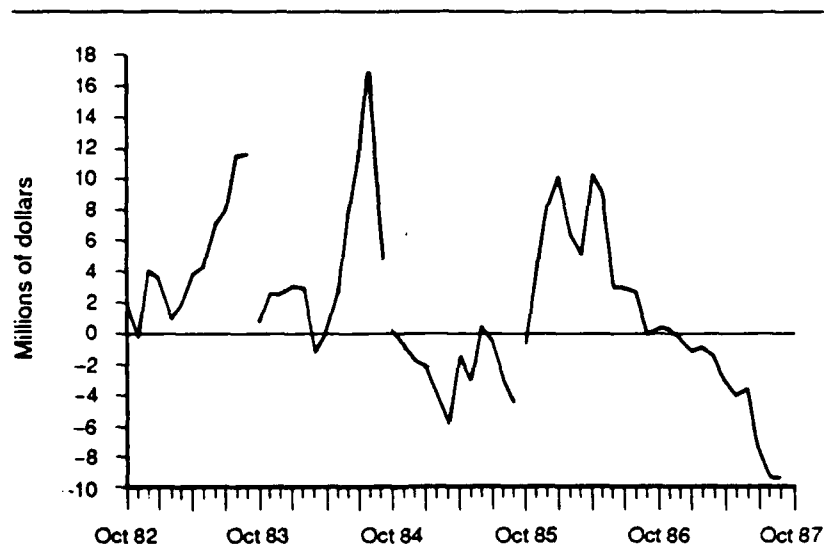


Figure 18. Officer basic pay estimation (cumulative fiscal year error)

Table 16. Officer basic pay forecast confidence intervals (in millions of dollars)

	Confidence level	
	95 percent	80 percent
One-month forecast	5.9	3.9
Three-month forecast	10.3	6.7

Table 16 shows the confidence one has in the accuracy of the predictions. For example, one has 95 percent confidence that true officer basic pay obligations will be within \$10.3 million of the forecast, based upon three months of strength data. The use of this information should be to warn Navy management when deviations from budgetary plans are more than month-to-month fluctuations and represent a significant divergence from plans. It is understood that these margins of error are larger than the Navy desires and that management of the MPN account to margins of approximately \$1 million is an explicit objective. However, the data show that this goal is not readily attainable and that the "noise" in the system is significantly greater than \$1 million.

Retired Pay Accrual

RPA became part of the MPN account in FY 1984. Each month, a specified percentage of basic pay is set aside to fund retirement. This is a pay item that should be amenable to very accurate prediction, given a knowledge of basic pay obligations. Table 8 displays a correlation of .69 between officer basic pay and RPA. However, this computation does not consider the changes in RPA rates that are described in table 11. If one controls for changes in RPA rates, a correlation of .92 between officer basic pay and RPA is obtained. If one multiplies monthly basic pay obligations by the appropriate RPA rates, estimates of RPA obligations are obtained. Figure 19, which displays the accuracy of the estimates (actual obligations less the estimates), reveals that in FY 1985, obligations were consistently above the estimates until the end of the year when there appears to have been a one-time adjustment. In FY 1986 and FY 1987, the estimates are nearly all within \$1 million of the estimates. Overall, the errors have a mean value of approximately \$0.3 million and a standard deviation of \$1.5 million. The estimates are indeed accurate: monthly fluctuations are comparatively minor around an estimate that is, on average, almost exactly correct.

Basic Allowance for Quarters

BAQ is intended to provide a cash allowance for military personnel not provided with government quarters adequate for themselves and their dependents to enable such personnel to

obtain civilian housing as a substitute. This description is taken from [3], which is an excellent and comprehensive source of information on military compensation. Not every officer receives BAQ, and for those personnel that do receive BAQ, the rates vary with grade and whether or not they have dependents. In addition, comparatively little money is obligated in partial BAQ for personnel in substandard government housing and bachelors in the field.

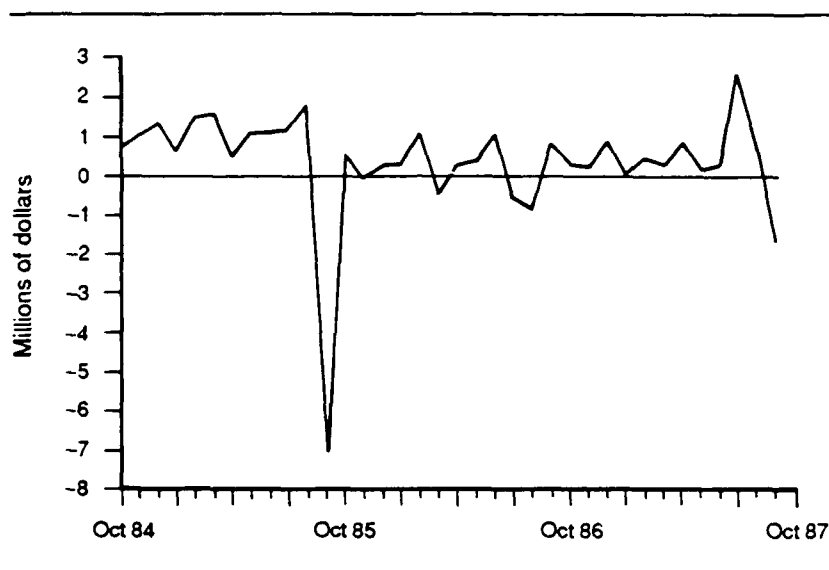


Figure 19. Officer RPA estimation error

BAQ obligations were estimated in a canonical fashion. First, data were obtained that describe the percentages of officers receiving BAQ at both the "with dependents" and the "without dependents" rates. The data are displayed in appendix C and are annual observations for FY 1983 to FY 1987. These entitlement distributions were multiplied by the appropriate monthly inventories and pay tables to obtain initial estimates of monthly BAQ obligations. A priori, this process has a number of sources of error. First, partial BAQ payments are not included in the estimation process, which presumably introduces a systematic underestimation of total BAQ payments. (Partial BAQ was not considered in the estimation process due to lack of data, the relatively small size of partial BAQ payments, and the desire for parsimony in the estimation approach.) Second, the use of annual BAQ entitlement distributions carries an implicit assumption that the distributions do not change during a year. This has a "smoothing" effect on the estimations and implies that the estimations will not account for all monthly variations. The estimates of BAQ were compared with actual BAQ obligations, and the differences are displayed in figure 20.

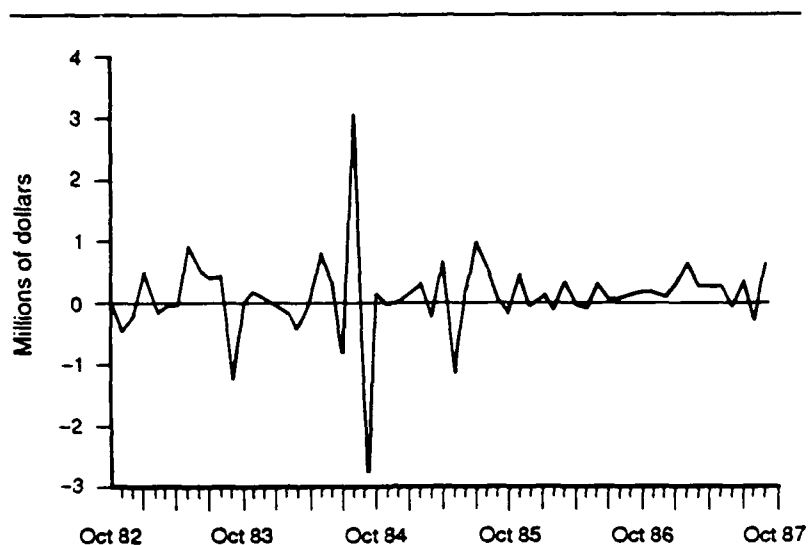


Figure 20. Officer BAQ initial estimate (actual minus estimated)

BAQ obligations are approximately \$25 million per month, and the figure shows that the BAQ estimates are quite accurate. Apart from a perturbation at the end of FY 1984, estimates are within roughly \$1 million of actual obligations, and the majority of estimates are within a few hundred thousand dollars. The estimates are marginally but consistently less than actual obligations, as was expected from the above comments. In order to correct for this underestimation, an adjustment factor was computed. Actual obligations were regressed upon the estimated obligations, constraining the line to pass through the origin. In order to eliminate any biases caused by pay raises, the data were normalized by BAQ rate changes, and all the observations were expressed in terms of FY 1983 BAQ rates. The results of the regression are described in table 17.

Table 17. Regression statistics for officer BAQ estimation

Regression coefficient	=	1.004
Standard error of coefficient	=	.004
t-statistic	=	258.3
R-square	=	.55
Root mean square error	=	\$650,000
Coefficient of variation	=	3.0
Degrees of freedom	=	59
Durbin-Watson statistic	=	2.97

The regression results are encouraging. The t-statistic and R-square values are highly significant, and the root mean square error is not too large. Measures of the precision of the results are given by the prediction confidence intervals in table 18. (The data in table 18 are expressed in terms of FY 1987 pay rates.) The Durbin-Watson statistic indicates negative serial correlation, caused primarily by the large fluctuation in BAQ obligations at the end of FY 1984.

Table 18. Officer BAQ forecast confidence intervals (in millions of dollars)

	Confidence level	
	95 percent	80 percent
One-month forecast	1.5	1.0
Three-month forecast	2.6	1.7

Finally, if the original estimates are multiplied by the adjustment factor and compared to actual obligations, errors, as displayed in figure 21, are obtained. The estimates are now centered around actual obligation levels.

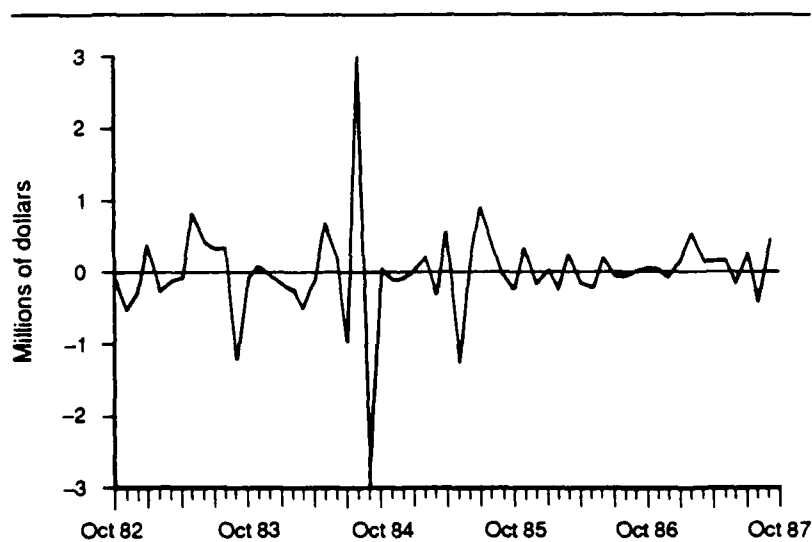


Figure 21. Officer BAQ final estimate (actual minus estimated)

Variable Housing Allowance

VHA is paid as a supplemental allowance for BAQ in high-cost housing areas. Similar to BAQ rates, VHA rates vary by grade and the existence of dependents. However, VHA rates also vary among several hundred housing areas across the United States, including Hawaii and Alaska since 1986. The complexity of VHA militates against obtaining concise methods of forecasting VHA obligations. This is demonstrated below. Initially, some examples of VHA rates are given to show the large variations that occur both between different locations and over time. Table 19 exhibits VHA rates that were set during FY 1983 to FY 1986, for each of four locations (VHA rates were unchanged during FY 1987).

Table 19. Officer VHA rates for selected locations (in dollars)

	O-7+	O-6	O-5	O-4	O-3	O-2	O-1	W-4	W-3	W-2
With Dependents										
San Diego, CA										
Oct 1982	159.08	206.02	217.88	207.97	162.60	130.25	154.07	183.08	170.67	178.20
Jan 1984	133.58	183.82	197.48	189.97	146.40	115.85	142.37	165.68	154.77	163.80
Jan 1985	247.92	278.06	264.92	256.67	206.14	167.01	174.09	251.61	236.46	231.15
Oct 1985	287.15	302.00	282.85	273.72	218.77	176.53	184.02	251.51	247.25	240.52
New Orleans, LA										
Oct 1982	120.90	178.18	182.41	189.88	117.88	94.07	125.00	148.21	142.88	153.25
Jan 1984	95.40	155.98	162.01	171.88	101.69	79.67	113.30	130.81	126.98	138.85
Jan 1985	137.87	178.25	157.18	170.49	146.58	114.96	103.59	171.00	176.42	168.51
Oct 1985	171.33	196.96	169.48	183.07	156.09	121.76	109.86	166.67	184.07	174.60
Without Dependents										
Washington, D.C.										
Oct 1982	147.46	168.94	176.78	183.60	151.52	117.34	129.63	169.62	151.29	156.74
Jan 1984	71.10	125.10	159.78	168.72	138.43	105.95	120.64	155.21	138.40	145.33
Jan 1985	167.74	197.76	210.29	207.73	218.45	165.48	162.07	233.17	219.56	218.83
Oct 1985	197.90	215.78	224.81	221.77	231.49	174.78	171.24	233.98	229.69	228.21
Norfolk/ Portsmouth, VA										
Oct 1982	50.85	91.32	101.02	116.16	79.06	54.38	84.93	93.83	86.91	95.17
Jan 1984	30.48	73.13	84.04	101.26	65.94	42.99	75.94	79.42	74.02	83.80
Jan 1985	120.02	146.33	148.71	143.82	129.10	109.86	112.33	177.37	152.62	157.14
Oct 1985	147.67	161.67	159.99	154.52	137.44	116.24	118.89	169.19	159.27	163.27

The large variations in rates around the country are to be expected: houses cost more in San Diego than in Norfolk. However, the data contain several anomalies. For example, there are frequent "VHA rate inversions," where personnel in higher pay grades receive smaller amounts of VHA. This is logical, if unexpected, given the manner in which VHA is computed as a supplement to BAQ.

A number of other complexities in the data cause problems from a modeling perspective. First, consider the changes in VHA rates over time. The data indicate a drop in VHA between FY 1983 and FY 1984, a large rise in VHA between FY 1984 and FY 1985, and a modest rise in VHA between FY 1985 and FY 1986. However, beneath these generalities there is a large amount of variation. Table 20 exhibits the percentage changes in VHA rates that occurred for the data found in table 19. Evidently, the changes in VHA rates have varied substantially across pay grades and between locations. These variations make any attempt to obtain a summary method of estimating VHA obligations very difficult. Another way of viewing the instability in VHA rates is to consider the distribution of VHA rates across pay grades. For example, all the rates for a location may be expressed as a fraction of the VHA rate for flag-level officers at that location. Table 21 contains such data. The table shows large variations both between locations and over time, once again indicating that a concise forecast of VHA obligations is not readily attained.

Table 20. Percentage changes in officer VHA rates over time

	O-7+	O-6	O-5	O-4	O-3	O-2	O-1	W-4	W-3	W-2
San Diego, CA										
FY 1983-1984	-16	-11	-9	-9	-10	-11	-8	-10	-9	-8
FY 1984-1985	86	51	34	35	41	44	22	52	53	41
FY 1985-1986	16	9	7	7	6	6	6	0	5	4
New Orleans, LA										
FY 1983-1984	-21	-12	-11	-9	-14	-15	-9	-12	-11	-9
FY 1984-1985	45	14	-5	-1	44	44	-9	31	39	21
FY 1985-1986	24	10	8	7	6	6	6	-3	4	4
Washington, D.C.										
FY 1983-1984	-52	-26	-10	-8	-9	-10	-7	-8	-9	-7
FY 1984-1985	136	58	32	23	58	56	34	50	59	51
FY 1985-1986	18	9	7	7	6	6	6	0	5	4
Norfolk, VA										
FY 1983-1984	-40	-20	-17	-13	-17	-21	-11	-15	-15	-12
FY 1984-1985	294	100	77	42	96	156	48	123	106	88
FY 1985-1986	23	10	8	7	6	6	6	-5	4	4

Table 21. Officer VHA rate distributions across pay grades

	O-7+	O-6	O-5	O-4	O-3	O-2	O-1	W-4	W-3	W-2
San Diego, CA										
FY 1983	1.00	1.30	1.37	1.31	1.02	0.82	0.97	1.15	1.07	1.12
FY 1984	1.00	1.38	1.48	1.42	1.10	0.87	1.07	1.24	1.16	1.23
FY 1985	1.00	1.12	1.07	1.04	0.83	0.67	0.70	1.01	0.95	0.93
FY 1986	1.00	1.05	0.99	0.95	0.76	0.61	0.64	0.88	0.86	0.84
New Orleans, LA										
FY 1983	1.00	1.47	1.51	1.57	0.98	0.78	1.03	1.23	1.18	1.27
FY 1984	1.00	1.64	1.70	1.80	1.07	0.84	1.19	1.37	1.33	1.46
FY 1985	1.00	1.29	1.14	1.24	1.06	0.83	0.75	1.24	1.28	1.22
FY 1986	1.00	1.15	0.99	1.07	0.91	0.71	0.64	0.97	1.07	1.02
Washington, D.C.										
FY 1983	1.00	1.15	1.20	1.25	1.03	0.80	0.88	1.15	1.03	1.06
FY 1984	1.00	1.76	2.25	2.37	1.95	1.49	1.70	2.18	1.95	2.04
FY 1985	1.00	1.18	1.25	1.24	1.30	0.99	0.97	1.39	1.31	1.30
FY 1986	1.00	1.09	1.14	1.12	1.17	0.88	0.87	1.18	1.16	1.15
Norfolk, VA										
FY 1983	1.00	1.80	1.99	2.28	1.55	1.07	1.67	1.85	1.71	1.87
FY 1984	1.00	2.40	2.76	3.32	2.16	1.41	2.49	2.61	2.43	2.75
FY 1985	1.00	1.22	1.24	1.20	1.08	0.92	0.94	1.48	1.27	1.31
FY 1986	1.00	1.09	1.08	1.05	0.93	0.79	0.81	1.15	1.08	1.11

In spite of the above reservations regarding the forecasting of VHA, two models were developed. First, a simple model was estimated in which VHA was regressed upon basic pay. Thus, ordinary-least-squares techniques were used to fit a line of the form,

$$VHA = \alpha + \beta * \text{basic pay} .$$

Basic pay was used instead of total officer strength because variations in pay grade distribution, etc., are reflected in basic pay obligations, and such variations have an effect on VHA obligations. The statistics from this regression are shown in table 22.

The results of the regression are not very useful for prediction purposes. Although the R-square value is rather large and certainly significant, the estimates are so imprecise as to be of little value to Navy management. This imprecision is reflected in the root mean square error and coefficient of variation statistics. A 95-percent confidence interval around a prediction arising

from the above model would be \$1.6 million either side of a point estimate. FY 1987 values of VHA obligations were approximately \$10 million per month. So, the margin of error in the estimates is large in comparison to the size of VHA obligations.

Table 22. Initial regression statistics for officer VHA

Constant term (α)	=	-\$10.6 million
Basic pay coefficient (β)	=	0.116
Standard error of β	=	.009
t-statistic for β	=	13.1
R-square	=	.74
Root mean square error	=	\$0.8 million
Coefficient of variation	=	10.0
Degrees of freedom	=	58
Durbin-Watson statistic	=	0.67 ^a

a. The Durbin-Watson statistic reflects the large amount of serial correlation that may be found in the estimate errors. The serial correlation is caused by the omission of variables that capture changes in VHA rates.

The model does not consider the effect of compensation changes on either basic pay or VHA; VHA rate changes as an overall percentage change are not easily expressed. However, rate changes did occur at certain points in time, and a regression line can be estimated that includes dummy variables for the four changes in VHA rates that occurred during FY 1983 to FY 1987. In order to make basic pay commensurate, basic pay obligations were normalized by the various increases that occurred during the 1983 to 1987 timeframe (in other words, basic pay obligations were converted to an FY 1983 pay table basis). Thus, the following model was estimated:

$$VHA = \alpha + \beta_1 * \text{Normalized Basic Pay} + \beta_2 * \text{RAISE-84} \\ + \beta_3 * \text{RAISE-85} + \beta_4 * \text{RAISE-86} ,$$

where *RAISE-84*, *RAISE-85*, and *RAISE-86*, are dummy variables corresponding to rate changes in VHA. The dummy variables take a value of 0 before the rate change takes effect and of 1 thereafter. Table 23 contains the results of the regression.

The data in table 23 show that this model provides a considerably better estimate of VHA obligations. Not only has the R-square statistic improved, but the estimates are more precise. A

95-percent confidence interval is approximately \$0.8 million on either side of a point estimate, a considerable improvement on the earlier model. The Durbin-Watson statistic shows that the later model has eliminated nearly all serial correlation in the estimate errors. The coefficients of the dummy variables represent the effects on monthly VHA obligations caused by the various rate changes. Thus, for example, the change in VHA rates in January 1985 caused a monthly decline in obligations of approximately \$0.8 million.

Table 23. Final regression statistics for officer VHA

Constant term (α)	=	-\$0.93 million
Basic pay coefficient (β_1)	=	0.053
RAISE-84 coefficient (β_2)	=	-\$0.81 million
RAISE-85 coefficient (β_3)	=	\$2.65 million
RAISE-86 coefficient (β_4)	=	\$0.66 million
Standard error of β_1	=	.017
Standard error of β_2	=	.17
Standard error of β_3	=	.18
Standard error of β_4	=	.17
t-statistic for β_1	=	3.1
t-statistic for β_2	=	-4.7
t-statistic for β_3	=	14.5
t-statistic for β_4	=	3.9
R-square	=	.93
Root mean square error	=	\$0.4 million
Coefficient of variation	=	5.2
Degrees of freedom	=	55
Durbin-Watson statistic	=	1.82

Although this model shows considerably more accuracy than the first, it is still imprecise. A confidence interval of approximately 8 percent either side of a point estimate (i.e., \$0.8 million on either side of \$10 million) has a substantial margin of error. In addition, the next time the VHA rates change, the above model will prove inadequate. A further dummy variable will have to be included to account for every rate change, and several months of data will be required after a rate change occurs, before its impact can be estimated. The use of the above VHA estimation approach is thus limited. The underlying problem is the restriction to obtaining a concise estimation technique that is amenable to implementation on a microcomputer—the guideline under which this study proceeded. If one uses the Navy's mainframe computers, accurate estimates of VHA obligations should be readily attainable. The personnel master files would be processed to obtain personnel geographical distribution. This information would be used to compute VHA obligations in conjunction with the VHA tables. This task is straightforward, but rather laborious, and requires a large computer.

Basic Allowance for Subsistence

BAS is paid to every officer, and each officer receives the same amount of BAS. Predicting BAS obligations is therefore a simple task, given a knowledge of officer strength.

Between FY 1983 and FY 1987, BAS increased at the same rate as basic pay. Monthly estimates of BAS obligations were obtained by multiplying "average strength" by appropriate BAS rates. Monthly "average strength" was assumed to be the mean of successive monthly end strength counts. The estimates were compared to actual obligations and the results of this comparison are shown in figure 22.

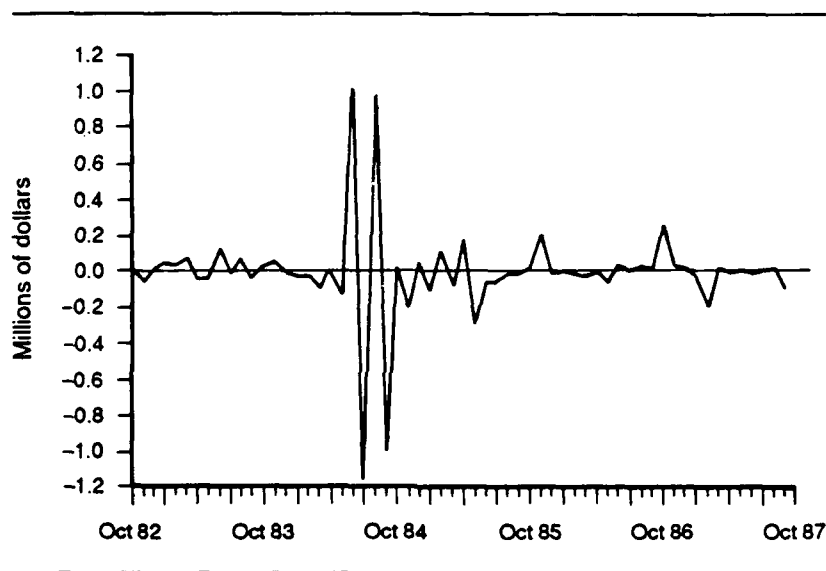


Figure 22. Officer BAS estimates (actual minus predicted)

Given that monthly BAS obligations are approximately \$8 million, the estimates are consistently accurate. The end of FY 1984 is an exception to this. In fact, the average error in the estimates is approximately \$5,000, with a standard deviation of \$281,000. This shows that the estimates are not biased either above or below actual obligations, although the standard deviation is uncomfortably large. The situation can be improved by ignoring the data for the last four months in FY 1984. It appears as if a one-time series of accounting problems occurred in 1984, with one month's obligations being under and the next month's being over in order to compensate, etc. After these outliers are removed from the data, an average estimate error of less than \$3,000 and a standard deviation of approximately \$89,000 can be obtained. This simple estimation method does indeed provide an accurate forecast of officer BAS obligations.

Social Security Tax

Estimating FICA obligations is somewhat more complicated than was the case for BAS. Figure 7 shows an upward trend in FICA obligations, which is common to other MPN pay categories. However, officer FICA obligations also exhibit a trough in obligations occurring at the end of each calendar year. The cause of these troughs is the pay cap on FICA obligations: above a certain annual pay level no FICA payments are required.

So, although it involves several computations, estimating FICA obligations is not conceptually difficult. One needs to multiply inventories by appropriate FICA and basic pay rates, making sure to place a cap on calendar year obligations from any individual. These computations were carried out, and the resulting estimates were compared with actual FICA obligations. Figure 23 displays the results of the comparison: the estimates are consistently less than actual obligations. This is not unexpected, since FICA is defined as a percentage of basic pay, and the analogous estimates for basic pay were consistently low. As was the case with basic pay, an adjustment factor was estimated. Actual FICA obligations were regressed upon the above estimates, restricting the intercept to the origin. The data were normalized by basic pay and FICA rate changes before the regression in order to make the data commensurate and to remove any bias caused by the rate changes. The results of the regression are shown in table 24.

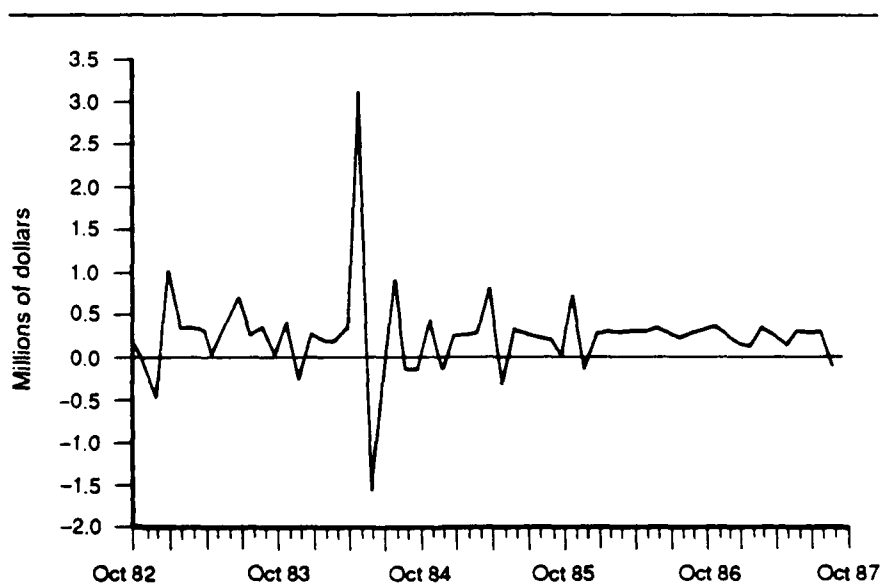


Figure 23. Initial officer FICA estimate (actual minus predicted)

Table 24. Regression statistics for officer FICA estimation

Regression coefficient	=	1.024
Standard error of coefficient	=	.007
t-statistic	=	157.5
R-square	=	.61
Root mean square error	=	\$0.5 million
Coefficient of variation	=	4.93
Degrees of freedom	=	59
Durbin-Watson statistic	=	2.68

The regression results are encouraging. The R-square and t-statistic are highly significant, although the precision of the results is less impressive. Measures of the precision of the results are given by the prediction confidence intervals in table 25. (The data in table 25 are expressed in terms of FY 1987 basic pay and FICA rates.)

**Table 25. Officer FICA forecast confidence intervals
(in millions of dollars)**

	95 percent	80 percent
One-month forecast	1.0	0.6
Three-month forecast	1.7	1.0

Monthly FICA obligations are approximately \$10 million. So, a 95-percent confidence interval of \$1 million on either side of a point estimate is rather large. The final FICA estimates are compared with actual obligations in figure 24.

ESTIMATION OF ENLISTED STRENGTH-RELATED OBLIGATIONS

Basic Pay

The analysis of enlisted basic pay is similar to the analogous analysis for officers. Basic pay is estimated in a canonical fashion by applying pay tables to inventory counts. The starting point of the analysis is the computation of average monthly basic pay for each pay grade. Quarterly extracts of the enlisted master file were processed to produce distributions of pay grade by length of service. These distributions were multiplied by the FY 1983 pay table to produce the data displayed in table 26. Table 26 exhibits data outside of the FY 1983 to FY 1987

timeframe, which is the period analyzed in this study. However, the data in table 26 have independent interest, so more extensive information is displayed.

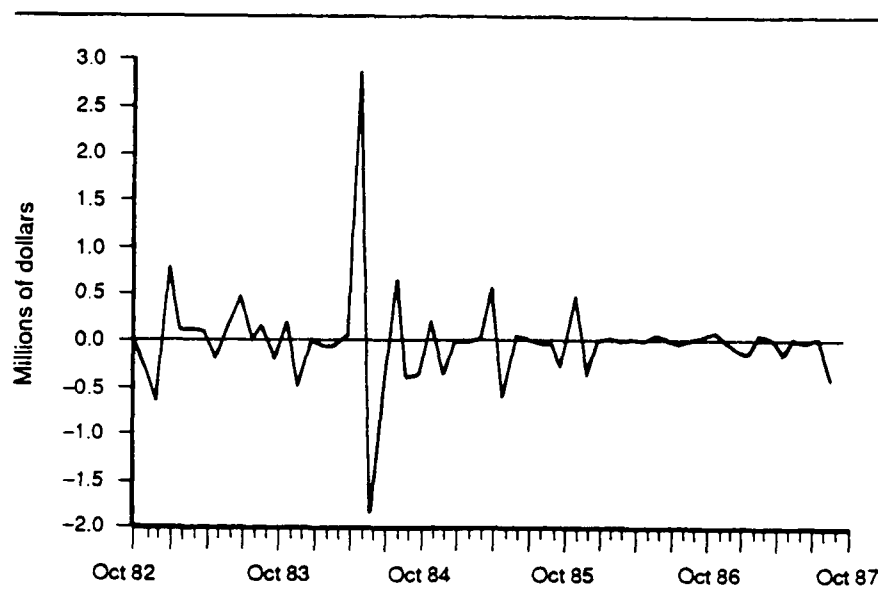


Figure 24. Final officer FICA estimate (actual minus predicted)

As was the case for officers, any variations in table 26 are due to changes in the length-of-service distribution within a rating. The data in table 26 are very stable. A more complete picture is provided by taking a weighted average of the above data to obtain data on the average enlisted basic pay of enlisted personnel, as a whole. Figure 25 displays the results of such computations, which show a steady and consistent rise in basic pay obligations during the past several years, caused by increases in the seniority of the Navy's enlisted pay grade distribution. The data in table 26 can be translated to the actual experienced average pay rates by inflating the data by the pay raises shown in table 10.

Table 26 lists average basic pay, based on an FY 1983 pay table, at certain fixed points in time, the last day in every quarter from September 1982 to March 1988. The analysis requires data on average pay during a month for each month during FY 1983 to FY 1987. The table was used to estimate the required information in the same three steps as were used for officer data. Initially, the data in table 26 were escalated by the various pay raises that occurred during FY 1983 to FY 1987. The resulting data were interpolated to provide an estimate of average pay at the end of each month. Finally, the average of successive end-of-month estimates was computed as a proxy for average pay during the intervening month. In this fashion, estimates for average enlisted basic pay, by pay grade, for each month during FY 1983 to FY 1987 were obtained.

Table 26. Average monthly enlisted basic pay (FY 1983 pay table)

	E-9	E-8	E-7	E-6	E-5	E-4	E-3	E-2	E-1
Sep 1982	2,036	1,684	1,412	1,163	931	784	690	643	574
Dec 1982	2,040	1,688	1,414	1,165	934	786	690	643	574
Mar 1983	2,044	1,692	1,418	1,165	932	787	692	643	574
Jun 1983	2,045	1,694	1,421	1,168	936	790	693	643	574
Sep 1983	2,046	1,692	1,413	1,165	936	787	692	643	574
Dec 1983	2,049	1,695	1,413	1,162	932	786	690	643	574
Mar 1984	2,050	1,694	1,412	1,161	932	787	689	643	574
Jun 1984	2,050	1,694	1,410	1,157	931	787	689	643	574
Sep 1984	2,056	1,697	1,410	1,162	937	790	691	643	574
Dec 1984	2,056	1,695	1,411	1,158	936	790	692	643	574
Mar 1985	2,053	1,690	1,411	1,156	935	789	692	643	574
Jun 1985	2,048	1,687	1,408	1,156	936	789	692	643	574
Sep 1985	2,050	1,690	1,406	1,156	936	789	691	643	574
Dec 1985	2,048	1,687	1,406	1,155	936	790	691	643	574
Mar 1986	2,048	1,685	1,406	1,155	937	789	691	643	574
Jun 1986	2,045	1,682	1,406	1,156	937	788	690	643	574
Sep 1986	2,049	1,685	1,404	1,157	941	791	691	643	574
Dec 1986	2,048	1,685	1,405	1,157	941	791	690	643	574
Mar 1987	2,049	1,685	1,405	1,159	943	794	691	643	574
Jun 1987	2,046	1,681	1,408	1,158	942	791	690	643	574
Sep 1987	2,051	1,684	1,405	1,160	945	792	691	643	574
Dec 1987	2,054	1,684	1,407	1,160	944	791	689	643	574
Mar 1988	2,059	1,688	1,409	1,164	949	794	691	643	574

The next stage of the analysis involved the computation of an estimate of basic pay obligations. Average basic pay data were multiplied by analogous information on average strength to provide an initial estimate of basic pay obligations. Because the strength data were end-strength counts, it was again necessary to take the average of successive observations to provide average monthly strength estimates. After summing across pay grades, the computed estimate of total enlisted basic pay obligations was compared with obligations as reported by NMPC-7 and displayed in table B-1 of appendix B. The comparison is displayed in figure 26. This figure shows that the estimate is marginally but consistently less than actual obligations, especially in the last couple of years (on average, actual obligations were \$1.5 million larger than the estimates). The possible causes of inaccuracy in the estimation process are several: the estimation of average monthly pay and inventories; problems in the data-reporting systems; the existence of reimbursable monies in the MPN account; and the inclusion of the pay of officer candidates in enlisted obligations. The last item will cause a small but consistent underestimate of obligations, because officer candidates are not included in inventory counts obtained from the enlisted master file.

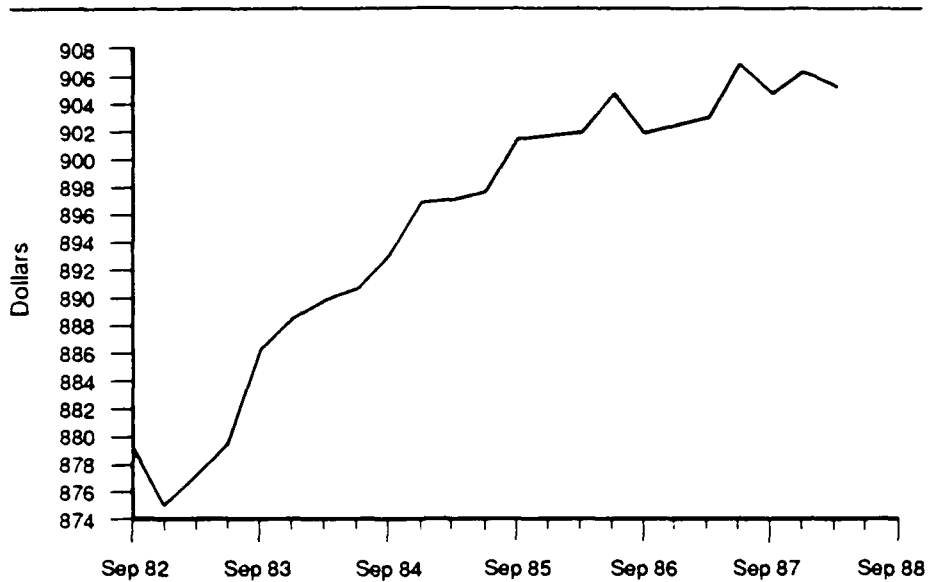


Figure 25. Enlisted average monthly basic pay (based on FY 1983 pay table)

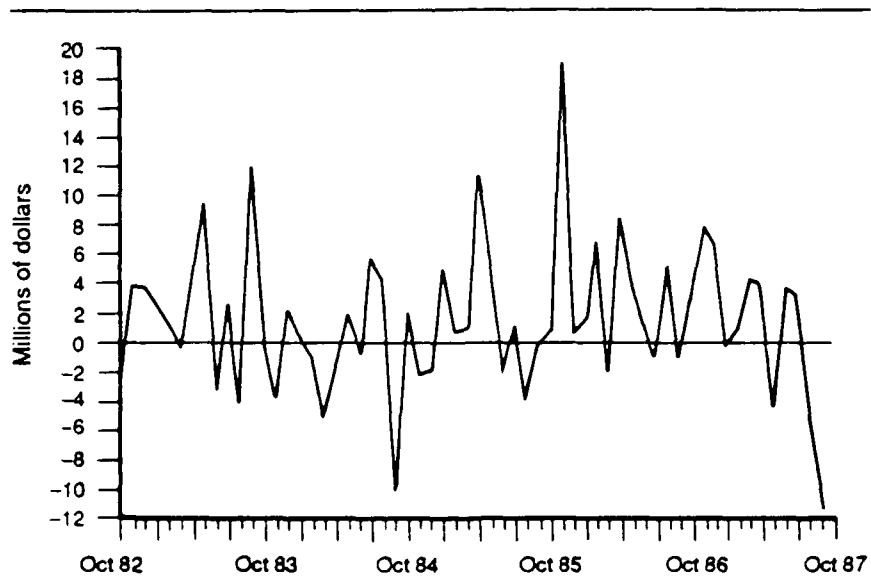


Figure 26. Enlisted basic pay obligations (actuals minus initial estimates)

In order to correct for these errors, an adjustment factor was computed using regression techniques. In detail, actual basic pay obligations were regressed upon the computed basic pay data using ordinary-least-squares estimation. The data were normalized by pay raises before the regression in order to make the data commensurate and to remove any biases caused by the pay raises. The regression line was constrained to pass through the origin. Table 27 displays pertinent statistics.

Table 27. Regression statistics for enlisted basic pay estimation

Regression coefficient	=	1.003
Standard error of coefficient	=	.001
t-statistic	=	726.4
R-square	=	.86
Root mean square error	=	\$4.7 million
Coefficient of variation	=	1.07
Degrees of freedom	=	59
Durbin-Watson statistic	=	2.02

Table 27 demonstrates that a factor of 1.003 provides an excellent adjustment to the initial computations in order to provide a more accurate estimate of enlisted basic pay. Given the closeness of the adjustment to unity, the significance of the difference between the regression coefficient and unity could be questionable. However, the smallness of the standard error of the estimate indicates that the adjustment factor is indeed significantly different from unity. The accuracy of the adjusted data can be seen in figures 27 and 28. Figure 27 shows monthly estimation errors, and figure 28 displays cumulative fiscal year errors. The monthly errors (root mean square error = \$4.7 million) need to be considered in the context of monthly obligations of approximately \$450 million (based upon FY 1983 pay rates). Figure 28 shows that the size of the errors shrinks relative to the cumulative fiscal year data, where annual obligations of approximately \$5.5 billion are considered. The accuracy of the estimates is more precisely displayed by considering confidence intervals around the predictions. Table 28 exhibits appropriate information.

Retired Pay Accrual

RPA became part of the MPN account in FY 1984. Each month, a specified percentage of basic pay is set aside to fund retirement. This pay item should be amenable to very accurate prediction, given a knowledge of basic pay obligations, and table 8 displays a correlation of .91 between enlisted basic pay and RPA. However the computation does not consider the changes in RPA rates that are described in table 11. If changes in RPA rates are controlled for, a correlation of .99 between officer basic pay and RPA is obtained. If monthly basic pay obligations are

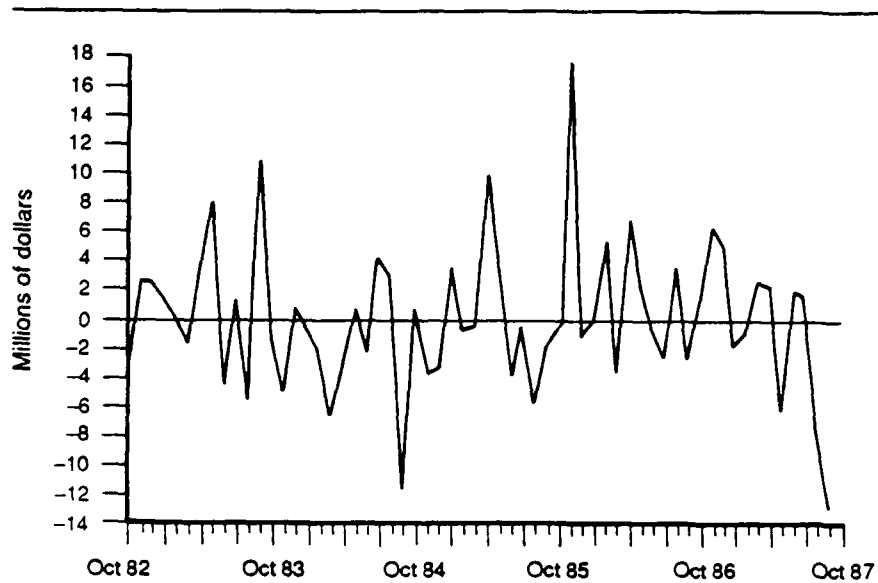


Figure 27. Enlisted basic pay obligations (actuals minus final estimates)

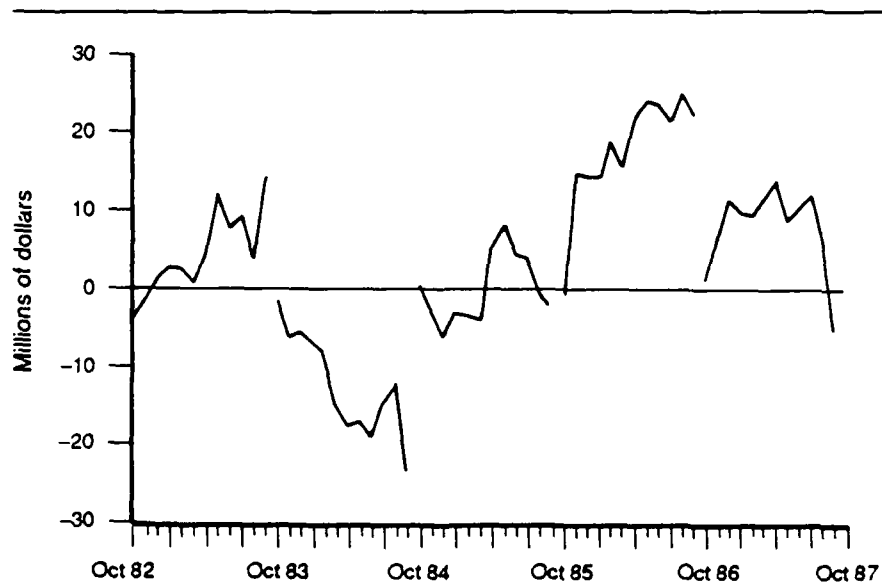


Figure 28. Enlisted basic pay estimation (cumulative fiscal year error)

multiplied by the appropriate RPA rates, estimates of RPA obligations are obtained. Figure 29 displays the accuracy of the estimates (actual obligations less the estimates). Given the magnitude of RPA obligations (approximately \$250 million per month), the estimates are very accurate with a few fluctuations. Overall, the errors have a mean value of approximately \$0.2 million and a standard deviation of \$2.0 million. As was the case for officer RPA, the estimates are indeed accurate: the monthly fluctuations are comparatively minor around an estimate that is, on average, almost exactly correct.

Table 28. Enlisted basic pay forecast confidence intervals (in millions of dollars)

	Confidence level	
	95 percent	80 percent
One-month forecast	9.3	6.1
Three-month forecast	16.1	10.6

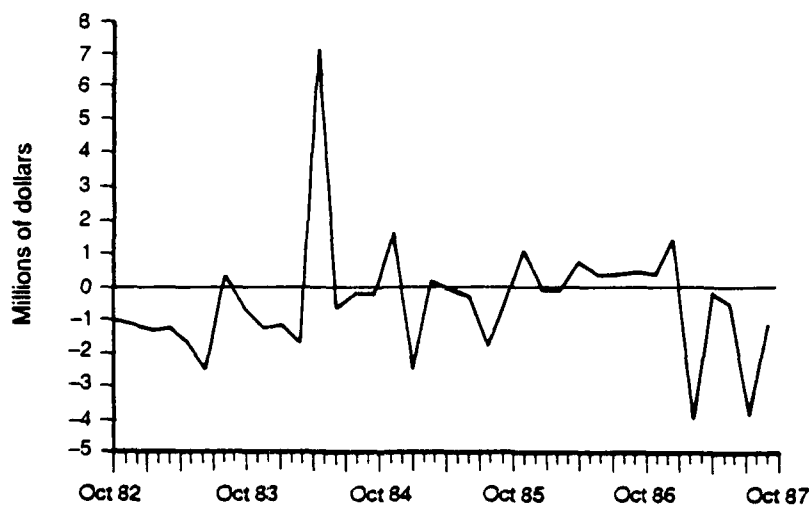


Figure 29. Enlisted RPA estimation error

Basic Allowance for Quarters

As was pointed out, BAQ is intended to provide a cash allowance to military personnel not provided with government quarters adequate for themselves and their dependents to enable such

personnel to obtain civilian housing as a substitute. Thus, not all enlisted personnel receive BAQ, and for those that do, the rates vary with grade and whether or not the personnel have dependents. In addition, comparatively little money is obligated in partial BAQ for personnel in substandard government housing and bachelors in the field.

Enlisted BAQ obligations were estimated in the same manner as were officer obligations. First, data were obtained that describe the percentages of enlisted personnel receiving BAQ at both the "with dependents" and the "without dependents" rates. The data are displayed in appendix C and are annual observations for FY 1983 to FY 1987. These entitlement distributions were multiplied by the appropriate monthly inventories and pay tables to obtain initial estimates of monthly BAQ obligations. This process has numerous sources of errors similar to those applying to officer BAQ as described previously. The estimates of BAQ were compared with actual BAQ obligations, and the differences are displayed in figure 30.

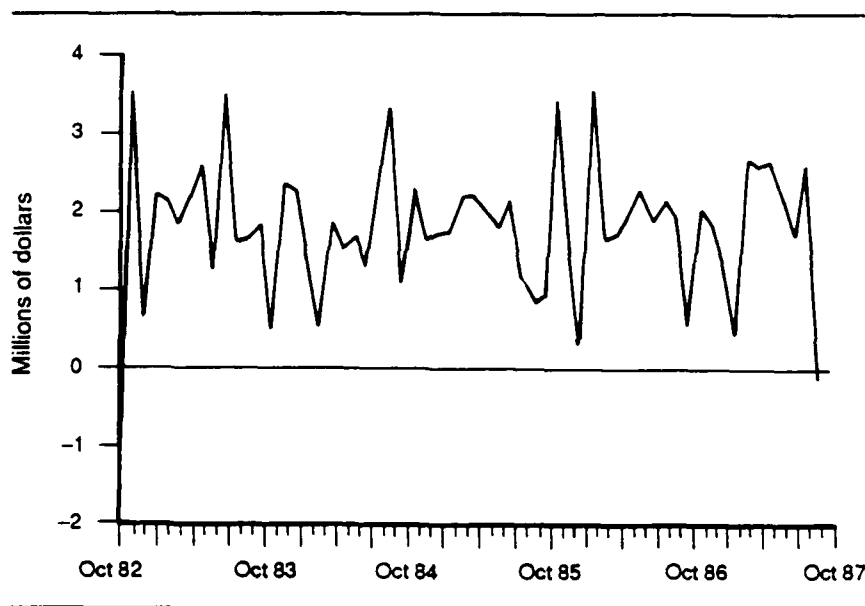


Figure 30. Enlisted BAQ obligations (actuals minus initial estimates)

The figure shows that the estimates are consistently less than actual obligations, as was to be expected from the above comments. In order to correct for this underestimation, an adjustment factor was computed. Actual obligations were regressed upon the estimated obligations, constraining the line to pass through the origin. In order to eliminate any biases caused by pay raises, the data were normalized by BAQ rate changes. Thus, all the observations were expressed in terms of FY 1983 BAQ rates. The results of the regression are described in table 29.

Table 29. Regression statistics for enlisted BAQ estimation

Regression coefficient	=	1.028
Standard error of coefficient	=	.002
t-statistic	=	552.2
R-square	=	.92
Root mean square error	=	\$858,000
Coefficient of variation	=	1.4
Degrees of freedom	=	59
Durbin-Watson statistic	=	2.27

The regression results are encouraging. The t-statistic and R-square values are significant, and the root mean square error is relatively small (at 1983 BAQ rates, average monthly BAQ obligations were more than \$61 million during 1983 to 1987). Measures of the precision of the results are given by the prediction confidence intervals in table 30. (The data in table 30 are expressed in terms of FY 1987 BAQ rates.)

**Table 30. Enlisted BAQ forecast confidence intervals
(in millions of dollars)**

	Confidence level	
	95 percent	80 percent
One-month forecast	1.7	1.1
Three-month forecast	2.9	1.9

Finally, if the original estimates are multiplied by the adjustment factor and compared to actual obligations, one obtains errors as displayed in figure 31. The estimates are now centered around actual obligation levels.

Variable Housing Allowance

As was the case with officers, the complexity of enlisted VHA militates against an ability to obtain concise methods of forecasting VHA obligations. This is demonstrated below. The examples of VHA rates given show the large variations in VHA rates that occur both between different locations and over time. Table 31 exhibits VHA rates that were set during FY 1983 to FY 1986, for each of four locations (VHA rates were unchanged during FY 1987).

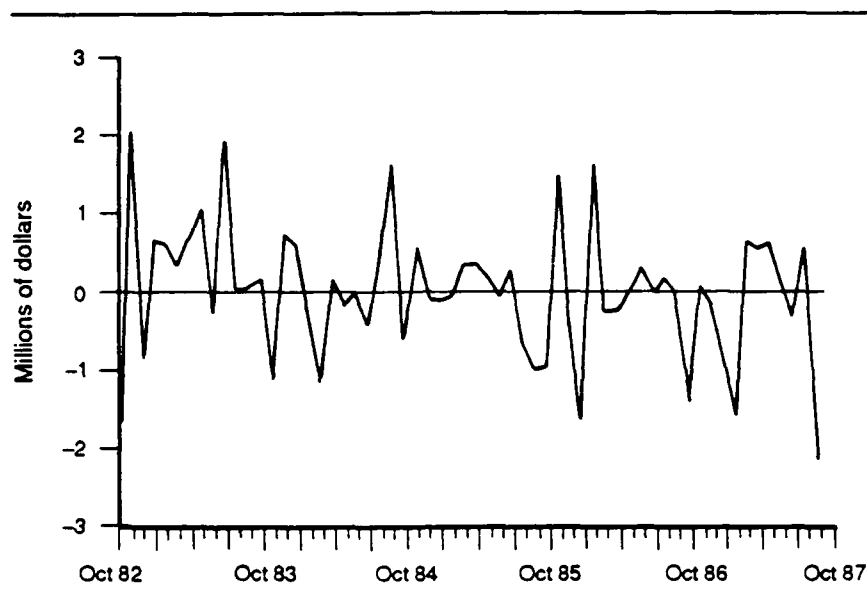


Figure 31. Enlisted BAQ obligations (actuals minus final estimates)

The data follow the same patterns as officer VHA data: large variations in rates as one moves around the country and a variety of anomalies in the data, such as rate inversions with respect to pay grade.

From a modeling perspective, the complexities in the data are familiar. First, consider the changes in VHA rates over time. The data indicate a drop in VHA between FY 1983 and FY 1984, a large rise in VHA between FY 1984 and FY 1985, and a modest rise in VHA between FY 1985 and FY 1986. However, beneath these generalities there is a large amount of variation. Table 32 exhibits the percentage changes in VHA rates that occurred for the data found in table 31. Evidently, the changes in VHA rates have varied substantially across pay grades and between locations. These variations make any attempt to obtain a summary method of estimating VHA obligations very difficult. Another way of viewing the instability in VHA rates is to consider the distribution of VHA rates across pay grades. For example, all the rates for a location may be expressed as a fraction of the VHA rate for E-9s at that location. Table 33 contains such data. The table shows large variations both between locations and over time, once again indicating that a concise forecast of VHA obligations is not readily attained.

In spite of the above reservations regarding the forecasting of VHA, two models were developed. The analysis followed the approach used for officer VHA. First, a simple model was estimated in which VHA was regressed upon basic pay. Thus, ordinary-least-squares techniques were used to fit a line of the form

$$VHA = \alpha + \beta * \text{Basic Pay} .$$

Basic pay was used instead of total enlisted strength because variations in pay grade distribution, etc., are reflected in basic pay obligations, and such variations have an effect on VHA obligations. The statistics from this regression are given in table 34.

Table 31. Enlisted VHA rates for selected locations (in dollars)

	E-9	E-8	E-7	E-6	E-5	E-4	E-3	E-2	E-1
With Dependents									
San Diego, CA									
Oct 1982	168.70	173.46	174.58	148.62	130.99	115.06	130.30	108.94	100.39
Jan 1984	153.40	159.36	161.38	136.62	119.89	105.16	121.90	100.54	91.99
Jan 1985	201.87	202.51	194.75	173.72	161.93	139.68	132.63	123.79	136.74
Oct 1985	214.88	214.97	205.36	182.97	159.43	145.50	135.90	133.82	141.72
New Orleans, LA									
Oct 1982	172.53	177.00	161.41	142.55	122.63	105.26	123.89	104.66	93.98
Jan 1984	157.23	162.90	148.21	130.55	111.53	95.36	115.49	96.26	85.58
Jan 1985	139.09	159.32	147.81	130.56	119.98	109.99	103.39	93.71	106.74
Oct 1985	148.33	169.93	155.97	137.55	125.83	114.26	105.12	102.15	110.14
Without Dependents									
Washington, D.C.									
Oct 1982	155.27	160.70	136.70	120.34	102.63	88.78	102.90	76.64	66.26
Jan 1984	144.36	150.64	128.05	112.73	95.24	82.10	97.26	71.53	61.42
Jan 1985	169.79	161.73	148.62	134.06	129.42	114.84	112.85	94.46	92.07
Oct 1985	180.55	171.44	156.72	141.13	135.80	119.87	116.03	101.64	95.57
Norfolk/Portsmouth, VA									
Oct 1982	79.00	85.37	74.76	65.99	54.11	44.39	60.27	40.27	33.13
Jan 1984	68.11	75.34	66.15	58.35	46.70	37.73	54.57	35.16	28.30
Jan 1985	121.77	116.58	99.07	86.57	82.49	73.59	69.44	55.28	57.56
Oct 1985	129.99	123.93	104.57	91.18	86.45	76.44	70.37	60.39	59.29

Table 32. Percentage changes in enlisted VHA rates over time

	E-9	E-8	E-7	E-6	E-5	E-4	E-3	E-2	E-1
With Dependents									
San Diego, CA									
San Diego, CA									
FY 1983-1984	-9	-8	-8	-8	-8	-9	-6	-8	-8
FY 1984-1985	32	27	21	27	35	33	9	23	49
FY 1985-1986	6	6	5	5	-2	4	2	8	4
New Orleans, LA									
FY 1983-1984	-9	-8	-8	-8	-9	-9	-7	-8	-9
FY 1984-1985	-12	-2	0	0	8	15	-10	-3	25
FY 1985-1986	7	7	6	5	5	4	2	9	3
Without Dependents									
Washington, D.C.									
FY 1983-1984	-7	-6	-6	-6	-7	-8	-5	-7	7
FY 1984-1985	18	7	16	19	36	40	16	32	50
FY 1985-1986	6	6	5	5	5	4	3	8	4
Norfolk/Portsmouth, VA									
FY 1983-1984	-14	-12	-12	-12	-14	-15	-9	-13	-15
FY 1984-1985	79	55	50	48	77	95	27	57	103
FY 1985-1986	7	6	6	5	5	4	1	9	3

The results of the regression are not very useful for prediction purposes. Although the R-square value is significant, the estimates are so imprecise as to be of little value to Navy management. This imprecision is reflected in the root mean square error and coefficient of variation statistics. A 95-percent confidence interval around a prediction arising from the above model would be \$3.8 million either side of a point estimate. FY 1987 values of VHA obligations were approximately \$25 million per month. So, the margin of error in the estimates is large compared to the size of VHA obligations.

The above model does not consider the impact of compensation changes, either for basic pay or VHA. However, rate changes did occur at certain points in time, and a regression line can be estimated that includes dummy variables for the four changes in VHA rates that occurred during FY 1983 to FY 1987. In order to make basic pay commensurate, basic pay obligations were normalized by the various increases that occurred during the 1983 to 1987 timeframe (in

Table 33. Enlisted VHA rate distributions across pay grades

	E-9	E-8	E-7	E-6	E-5	E-4	E-3	E-2	E-1
With Dependents									
San Diego, CA									
Oct 1982	1.00	1.03	1.03	0.88	0.78	0.68	0.77	0.65	0.60
Jan 1984	1.00	1.04	1.05	0.89	0.78	0.69	0.79	0.66	0.60
Jan 1985	1.00	1.00	0.96	0.86	0.80	0.69	0.66	0.61	0.68
Oct 1985	1.00	1.00	0.96	0.85	0.74	0.68	0.63	0.62	0.66
New Orleans, LA									
Oct 1982	1.00	1.03	0.94	0.83	0.71	0.61	0.72	0.61	0.54
Jan 1984	1.00	1.04	0.94	0.83	0.71	0.61	0.73	0.61	0.54
Jan 1985	1.00	1.15	1.06	0.94	0.86	0.79	0.74	0.67	0.77
Oct 1985	1.00	1.15	1.05	0.93	0.85	0.77	0.71	0.69	0.74
Without Dependents									
Washington, D.C.									
Oct 1982	1.00	1.03	0.88	0.78	0.66	0.57	0.66	0.49	0.43
Jan 1984	1.00	1.04	0.89	0.78	0.66	0.57	0.67	0.50	0.43
Jan 1985	1.00	0.95	0.88	0.79	0.76	0.68	0.66	0.56	0.54
Oct 1985	1.00	0.95	0.87	0.78	0.75	0.66	0.64	0.56	0.53
Norfolk/Portsmouth, VA									
Oct 1982	1.00	1.08	0.95	0.84	0.68	0.56	0.76	0.51	0.42
Jan 1984	1.00	1.11	0.97	0.86	0.69	0.55	0.80	0.52	0.42
Jan 1985	1.00	0.96	0.81	0.71	0.68	0.60	0.57	0.45	0.47
Oct 1985	1.00	0.95	0.80	0.70	0.67	0.59	0.54	0.46	0.46

Table 34. Initial regression statistics for enlisted VHA

Constant term (α)	=	-\$9.0 million
Basic pay coefficient (β)	=	0.066
Standard error of β	=	.007
t-statistic for β	=	9.5
R-square	=	.60
Root mean square error	=	\$1.9 million
Coefficient of variation	=	8.7
Degrees of freedom	=	58
Durbin-Watson statistic	=	1.63

other words, basic pay obligations were converted to an FY 1983 pay table basis). Thus, the following model was estimated:

$$VHA = \alpha + \beta_1 * \text{Normalized Basic Pay} + \beta_2 * \text{RAISE-84} \\ + \beta_3 * \text{RAISE-85} + \beta_4 * \text{RAISE-86} ,$$

where *RAISE-84*, *RAISE-85*, and *RAISE-86* are dummy variables corresponding to rate changes in VHA. The dummy variables take a value of 0 before the rate change takes effect and of 1 thereafter. Table 35 contains the results of the regression.

Table 35. Final regression statistics for enlisted VHA

Constant term (α)	=	-\$1.55 million
Basic pay coefficient (β_1)	=	0.0826
RAISE-84 coefficient (β_2)	=	-\$1.45 million
RAISE-85 coefficient (β_3)	=	\$4.61 million
RAISE-86 coefficient (β_4)	=	-\$0.59 million
Standard error of β_1	=	.017
Standard error of β_2	=	.72
Standard error of β_3	=	.78
Standard error of β_4	=	.73
t-statistic for β_1	=	2.1
t-statistic for β_2	=	-2.0
t-statistic for β_3	=	5.9
t-statistic for β_4	=	-0.8
R-square	=	.72
Root mean square error	=	\$1.62 million
Coefficient of variation	=	7.3
Degrees of freedom	=	55
Durbin-Watson statistic	=	2.33

The data in table 35 show that this model does not provide a considerably better estimate of VHA obligations. Precision and explanatory power are marginally improved as can be seen by considering the regression residuals for both methods of predicting enlisted VHA obligations. Figure 32 displays these estimation errors and indicates that the latter estimate provides a better model for the 1983 to 1985 timeframe. However, neither model explains the large fluctuations during FY 1986. If one disregards the variations during 1986, then the model appears to be reasonably accurate.

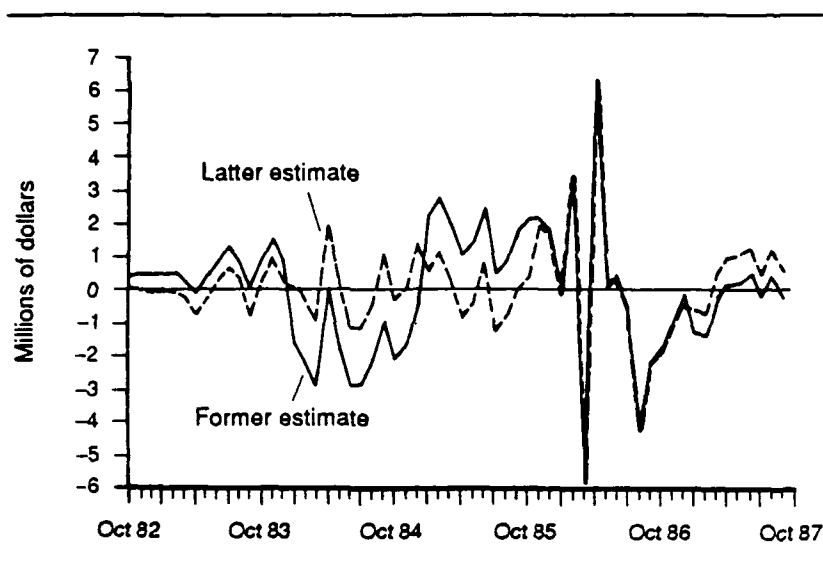


Figure 32. Enlisted VHA obligations (actuals minus estimates)

As is the case for officer VHA, however, the next time VHA rates change, the above model will prove inadequate. A further dummy variable will have to be included to account for every rate change, and several months of data will be required after a rate change occurs, before its impact can be estimated. Use of the above VHA estimation approach is thus limited. Considering VHA tables in conjunction with geographical distribution data obtained from personnel files is again appropriate.

Subsistence of Enlisted Personnel

Obligations for the subsistence of enlisted personnel take one of two forms, basic allowance for subsistence (BAS) or subsistence in kind (SIK). Enlisted personnel receive BAS if any of three conditions pertains: rations in kind are not available; permission to "mess" separately has been granted; or personnel are assigned to duty under emergency conditions where no government messing facilities are available. SIK represents the cost of the food provided to personnel in government messing facilities.

No intuitive relationship links a growth in end strength or a pay raise with the level of SIK obligations. SIK obligations reflect variations in the price of food and the number of personnel dining at government messing facilities. The lack of correlation between SIK and enlisted strength (shown in table 9) is thus not surprising. In fact, the average level of SIK obligations did not noticeably change between 1983 and 1987 (see figure 14). Therefore, no further analysis in this area was undertaken.

Enlisted BAS is more difficult to estimate than is officer BAS. Not all enlisted personnel receive BAS, and the rate varies among its recipients according to the aforementioned conditions.

However, during FY 1983 to FY 1987, the various BAS rates have remained the same relative size and have increased at the same rate as basic pay. Moreover, approximately 75 percent of BAS obligations derive from one category—personnel authorized to mess separately. It is thus reasonable to attempt to estimate BAS obligations as being a fixed amount of money per enlisted member. To accomplish this, BAS obligations were regressed on average monthly strength, with the regression line being constrained to pass through the origin (BAS obligations were normalized by pay raises that occurred during the 1983 to 1987 timeframe in a manner analogous to previous estimates). The results of the regression are displayed in table 36.

Table 36. Regression statistics for enlisted BAS estimation

Regression coefficient	=	72.9
Standard error of coefficient	=	.5
t-statistic	=	143.0
R-square	=	.24
Root mean square error	=	\$1.95 million
Coefficient of variation	=	5.4
Degrees of freedom	=	59
Durbin-Watson statistic	=	1.59

The regression results are not encouraging. The R-square value shows that the model does not explain a majority of the variation. In addition, the root mean square error implies a 95-percent confidence interval of approximately \$3.9 million around a point estimate. That margin of error is substantial in terms of 1983 BAS rates, where average obligations were approximately \$35 million per month. The regression coefficient infers that, on average, an enlisted member received \$72.9 per month in BAS. Another way of observing the model's accuracy is through the individual estimate errors, as displayed in figure 33. (The data in the figure have been converted to actual obligations, by inflating the regression residuals by pertinent BAS rate changes.) Unfortunately, figure 33 shows not only that the errors in the estimation process are sizable, but that the estimates have been getting progressively less accurate.

Social Security Tax

Estimating enlisted FICA obligations is less complex than the corresponding analysis for officers. The pay cap on FICA obligations has no impact on enlisted personnel. Thus enlisted FICA obligations can be estimated as a percentage of enlisted basic pay obligations. The percentage would be the prevailing FICA rate. If one carries out the computations and compares estimated and actual obligations, then one obtains the data displayed in figure 34. One observes that the estimate appears to be unbiased (the estimate errors have a mean value of approximately \$25,000). In addition, the size of the estimate errors is comparatively small, given that current

monthly enlisted FICA obligations are approximately \$37 million (the estimate errors have a standard deviation of approximately \$0.5 million). Accurate estimates of enlisted FICA obligations are thus readily obtained from corresponding information regarding basic pay.

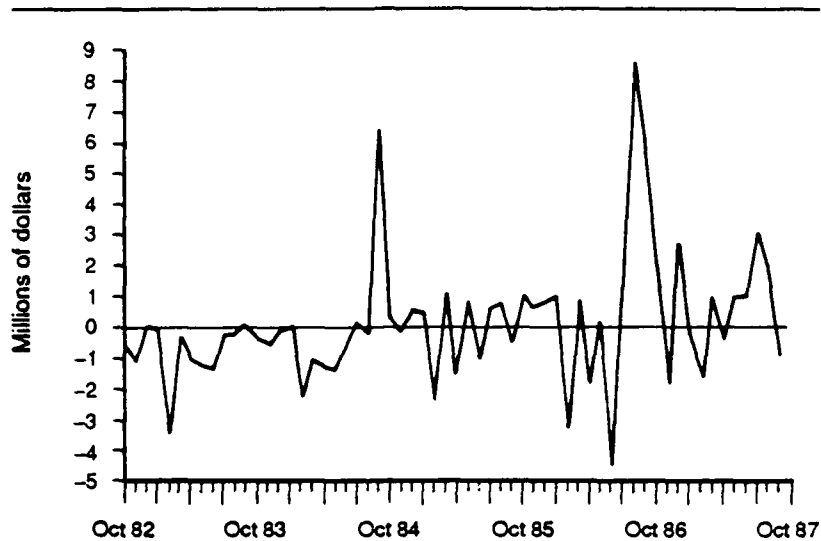


Figure 33. Enlisted BAS obligations (actuals minus estimates)

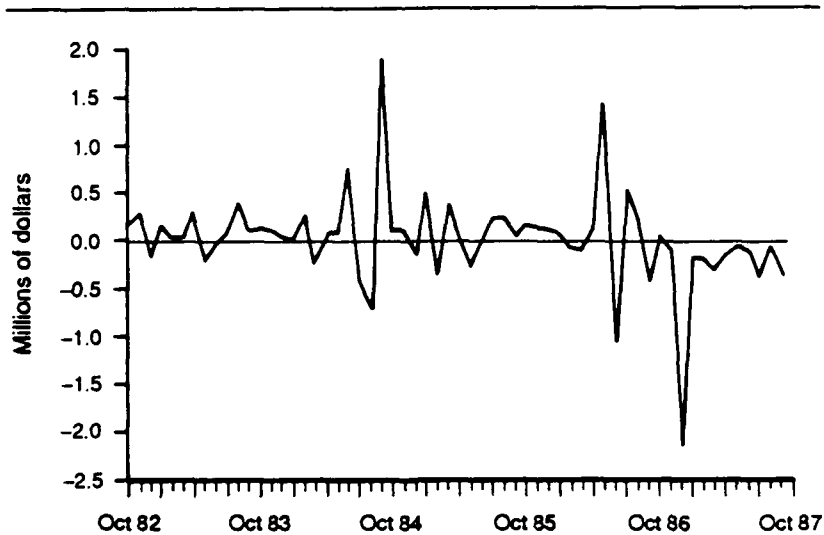


Figure 34. Enlisted FICA obligations (actuals minus estimates)

NON-STRENGTH-RELATED OBLIGATIONS

The above analysis of strength-related obligations has considered a large majority of the entire MPN account. The remaining "non-strength-related" obligations account for approximately 10 percent of the MPN appropriation. These obligations, by definition, are not amenable to the estimation techniques that were applied to "strength-related" obligations. All of the previous analysis was based on the presumption that a knowledge of inventory or basic pay obligations would suffice for the prediction of various MPN line items. If a pay category is not correlated with personnel strength, then one would expect this analytic approach to fail.

The analysis of non-strength-related obligations begins with a tabulation of its components and their FY 987 obligations (see table 37).

Table 37. FY 1987 monthly non-strength-related obligations (in millions of dollars)

Pay category	Obligations
Non-strength-related officer pay and allowances	
Incentive pay	95
Special pay	117
Other ^a	76
Non-strength-related enlisted pay and allowances	
Incentive pay	93
Special pay	259
Special duty assignment pay	51
Enlistment bonus	12
Reenlistment bonus	233
Other ^b	361
Cadets/midshipmen pay and allowances	36
Permanent change of station costs	517
Other ^c	45
Total	1,895

- a. Includes overseas station allowance, uniform allowance, family separation allowance, and separation payments.
b. Includes overseas station allowance, clothing allowance, family separation allowance, and separation payments.
c. Includes apprehension of deserters costs, death gratuities, unemployment compensation, survivor's benefits, and education benefits.

Although non-strength-related obligations aggregate to a sizable portion of the MPN account, many of its component parts are rather small, even insignificant from a perspective of the overall status of MPN obligations. For example, enlistment bonuses amount to approximately \$12 million a year. A 5-percent variation in enlistment bonus obligations has little effect on MPN expenditures as a whole.

Correlation of Cost Categories

The correlation of non-strength-related obligations with inventory size and/or basic pay was investigated. Table 38 contains a number of appropriate correlation coefficients. Not all possible correlations were computed because the large number of different coefficients might obscure the underlying observation that inventory size appears to have little relation to the subject pay categories. As with all previous computations, the data were monthly observations for FY 1983 to FY 1987.

Table 38. Correlation of non-strength-related obligations with strength and basic pay

	Basic pay	Strength
Officer		
Incentive pay	-.09	-.07
Special pay	.12	.26
Enlisted		
Special pay	.77	.81
SRB	.15	.15
Clothing allowance	.37	.47
Officer and enlisted		
PCS	.02	.01

The above pay items were chosen because each is a comparatively large part of non-strength-related obligations (FY 1987 enlisted clothing allowance obligations were approximately \$136 million). Enlisted special pay is the only item that exhibits large correlation with inventory size. This correlation is probably spurious for several reasons. Sea pay comprises roughly 80 percent of enlisted special pay, so the observed correlation is better described as a correlation between sea pay and inventory size. During the 1983 to 1987 timeframe, sea pay, basic pay, and end strength all grew. However, the growth in sea pay obligations was only partially caused by growth in end strength. The rise in sea pay obligations may be attributed to increases in the number of Navy ships, increases in sea pay tables (unrelated to basic pay raises), and increases in sea manning. Only the increases in sea manning could be explained by increases

in inventory. These coincidental alignments will probably not continue. Consequently, it would be inadvisable to attempt to predict sea pay obligations, whence special pay obligations, from a knowledge of end strength.

Two large contributors to non-strength-related obligations—permanent change of station (PCS) and selective reenlistment bonuses (SRB) costs—are now analyzed in order to ascertain whether they can be accurately estimated. As will be seen, neither SRB nor PCS costs are amenable to concise estimation. Instead, the detailed analysis that is carried out in the pertinent offices within OP-01 and NMPC is essential for even an aggregate understanding of obligations in this area. The same conclusion holds for other non-strength-related pay items.

Permanent Change of Stations Costs

PCS moves are categorized into six types: accession, training, operational, rotational, separation, and organized unit. Some PCS moves result in costs to the Navy, others do not. The relative impact of these move categories on obligations can be seen in table 39.

Table 39. Permanent change of station obligations, by fiscal year
(in millions of dollars)

	1983	1984	1985	1986	1987
Officer moves					
Accession	18.4	14.3	14.6	14.9	13.8
Training	22.3	24.1	22.4	27.6	27.4
Operational	33.3	34.6	35.4	38.8	35.2
Rotational	44.5	56.0	50.8	51.7	49.3
Separation	14.9	17.4	13.0	14.4	14.8
Organized unit	3.3	2.8	3.9	5.0	2.2
Enlisted moves					
Accession	55.8	53.1	56.7	59.1	55.7
Training	27.1	28.8	33.2	40.8	35.9
Operational	80.7	87.1	103.6	102.0	83.3
Rotational	121.7	142.7	148.2	139.4	128.1
Separation	51.1	46.9	50.9	57.7	59.7
Organized unit	16.5	12.1	16.0	16.7	14.6
Cadets/midshipmen					
Accession	0.4	0.3	0.3	0.3	0.2
Total	490.0	520.2	549.0	568.4	520.2

Table 39 shows that costs of the various PCS move categories do not change dramatically from one year to the next. However, beneath this gross level of accuracy, the data show no clear patterns. Obligations in some move categories rise, while others fall, from one year to the next. Moreover, patterns of change do not persist for all five years. All in all, the above data do not suggest that a knowledge of past obligations will lead to an accurate estimate of future obligations.

One may further investigate PCS costs by looking at the frequency and average costs of the various move categories. The possibilities for consideration are numerous. They all provide the same answer: PCS obligations vary too much to permit a concise and accurate forecasting model. The analysis therefore focuses on two move categories: enlisted rotational and officer operational. Analogous results may be readily attained for other move types. Figures 35 through 40 provide a variety of statistics. Figures 35 through 37 show obligations, move frequencies, and average move costs for enlisted operational moves. Similar information for officer operational moves is displayed in figures 38 through 40. The data are monthly observations for FY 1983 to FY 1987. The data for enlisted rotational moves show large monthly fluctuations in obligations. These fluctuations have been caused by variations in move frequencies, with the average cost of an enlisted rotational move staying fairly constant. The situation for officer operational moves is more complex, with large fluctuations occurring in both move frequencies and move costs. It is possible to partially capture the variation in all the move categories by considering the average cost and its standard deviation for each year, based upon monthly observations. The data are shown in tables 40 and 41.

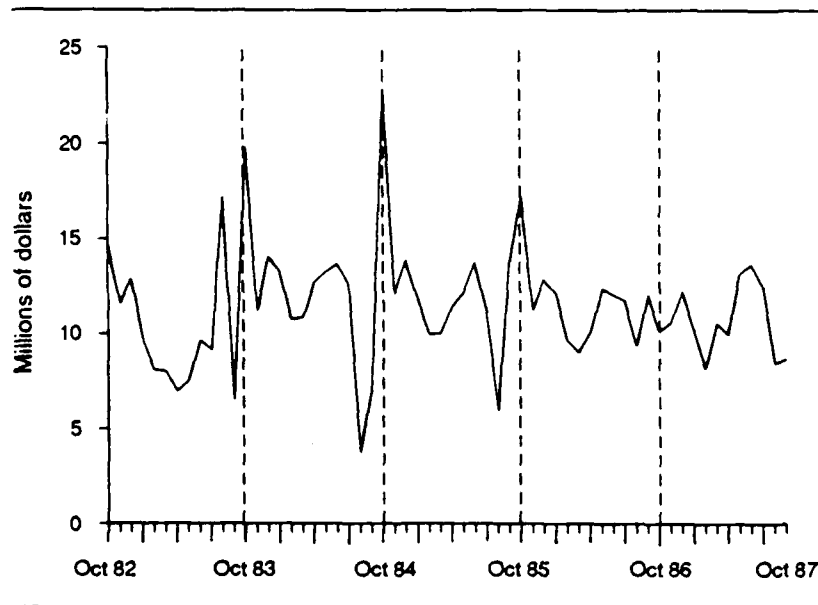


Figure 35. Enlisted rotational move obligations

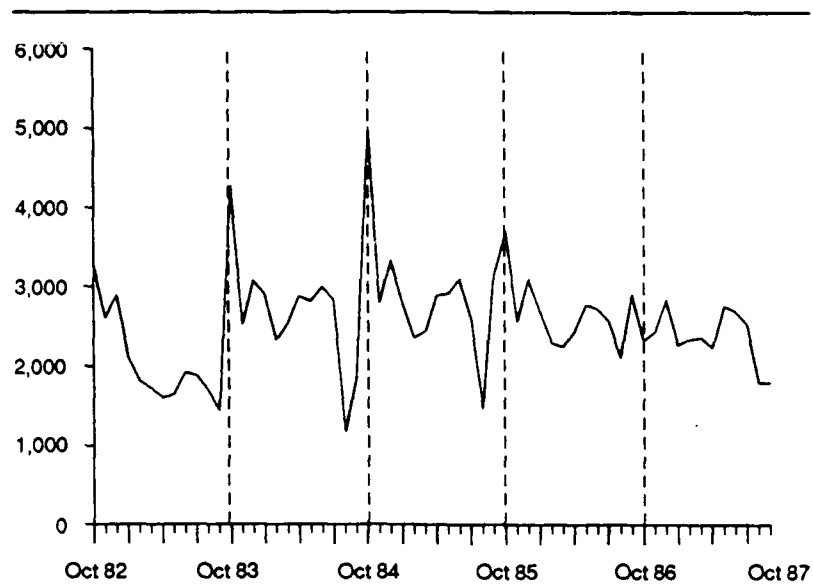


Figure 36. Enlisted rotational cost-move frequencies

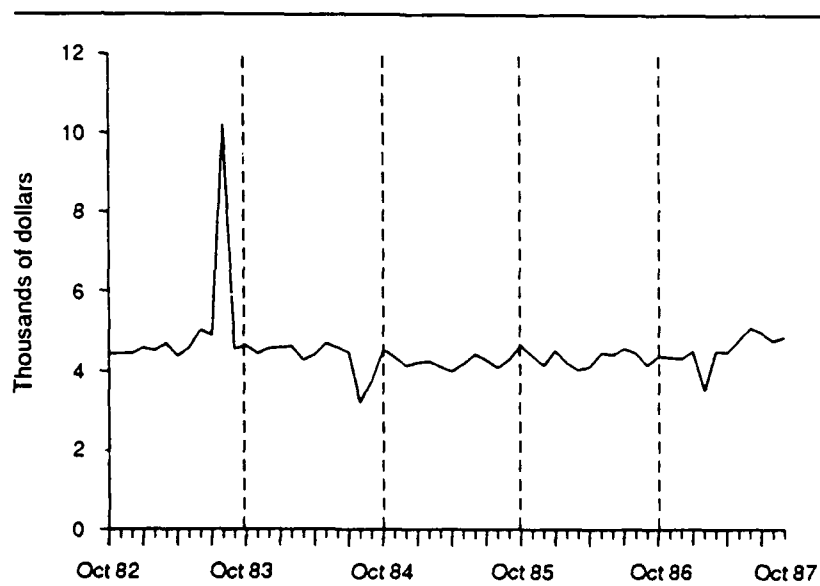


Figure 37. Average enlisted rotational move costs

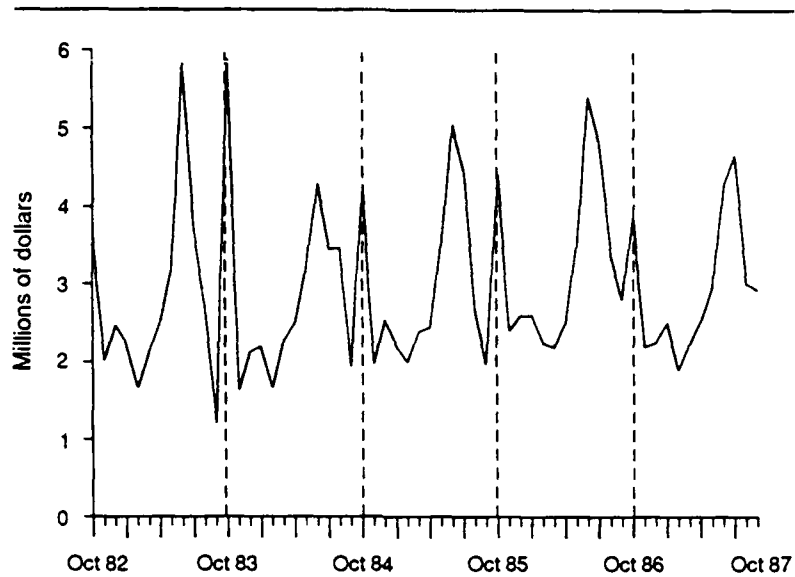


Figure 38. Officer operational move obligations

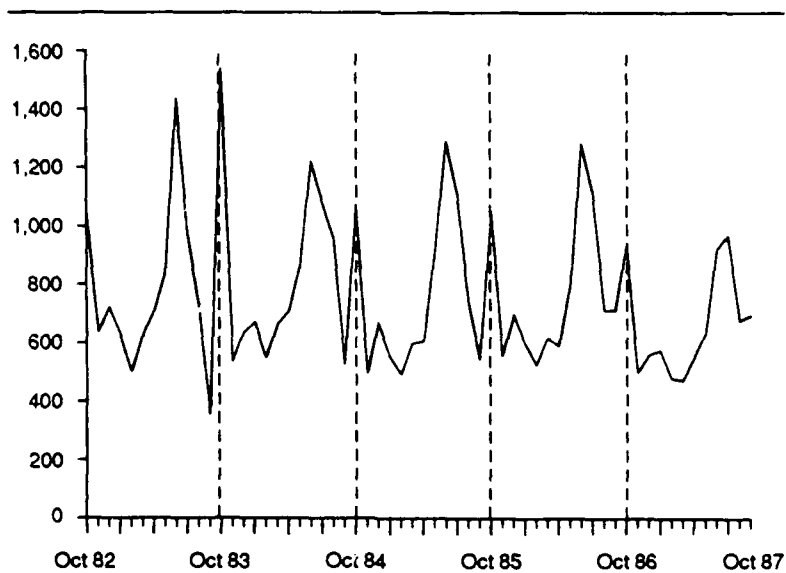


Figure 39. Officer operational cost-move frequencies

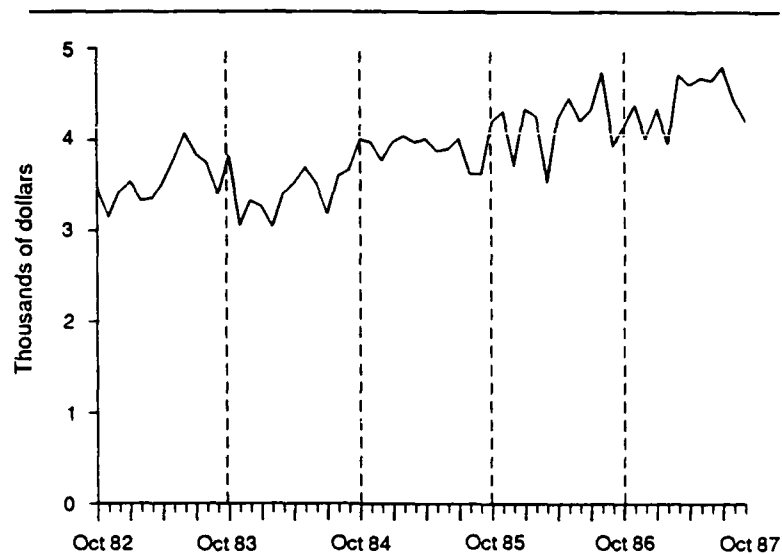


Figure 40. Average officer operational move costs

Table 40. Average costs of PCS moves, by fiscal year (dollars)

	1983	1984	1985	1986	1987
Officer moves					
Accession	2,563	2,582	2,023	2,147	2,382
Training	3,098	2,936	2,767	3,477	3,239
Operational	3,617	3,472	3,901	4,192	4,422
Rotational	9,146	9,125	8,751	8,547	8,502
Separation	2,872	3,430	2,483	2,654	2,551
Organized unit	3,579	3,591	3,622	6,476	3,336
Enlisted moves					
Accession	601	587	623	602	599
Training	1,097	1,117	1,143	1,375	1,335
Operational	1,868	1,762	2,038	2,231	2,381
Rotational	4,955	4,432	4,253	4,341	4,516
Separation	680	618	641	727	750
Organized unit	2,331	2,287	2,114	2,801	2,397

Table 41. Standard deviation of costs of PCS moves, by fiscal year (dollars)

	1983	1984	1985	1986	1987
Officer moves					
Accession	454	701	535	683	394
Training	423	327	320	411	391
Operational	247	244	141	311	273
Rotational	651	797	370	592	737
Separation	202	537	662	833	2,397
Organized unit	914	1,115	774	2,596	4,307
Enlisted moves					
Accession	151	89	67	221	126
Training	79	82	75	176	352
Operational	103	110	150	172	387
Rotational	1,555	421	149	194	388
Separation	130	64	30	44	36
Organized unit	455	363	488	1,086	2,308

The above data are discouraging from a planner's perspective. Frequently, no clear patterns regarding average move costs persist over several years. In addition, the variation in the data, as described by the standard deviations, is comparatively large with respect to average costs. Overall, attaining a concise estimate of PCS obligations does not seem possible. One must therefore consider the many factors that influence PCS moves in order to arrive at reasonable projections of obligations.

Selective Reenlistment Bonuses

SRB is intended to provide a monetary incentive for reenlisting to personnel in critical skills with high training costs. By applying SRB to particular skills on an as-needed basis, Navy management is able to redress force structure deficiencies in a cost-effective manner. As a corollary to this, SRB obligations are subject to many fluctuations. It is the nature of the SRB program for SRB levels to vary with the manning of ratings and Naval Enlisted Classifications (NECs). In addition, the SRB program is subject to cuts by the Navy in order to keep overall MPN obligations within authorized limits, and such policy actions cannot be predicted from merely a knowledge of inventories. These variations do not permit the concise estimation techniques pursued in this study.

The analysis of SRB begins with a review of obligations. Figure 41 shows monthly obligations for FY 1983 to FY 1987. The notable variation in obligations from one month to the next encourages a study of the factors that determine SRB obligations. The level of spending in

the SRB program varies with retention rates, the size of the pool of personnel who are eligible for reenlistment, reenlistment lengths, and the bonus level of SRB in individual ratings and NECs. SRB obligations cannot be accurately forecast without precise estimates of all of the above causal factors in SRB obligations. Unfortunately, these factors are difficult to predict, being subject to substantial monthly variations, mostly beyond the control of the Navy.

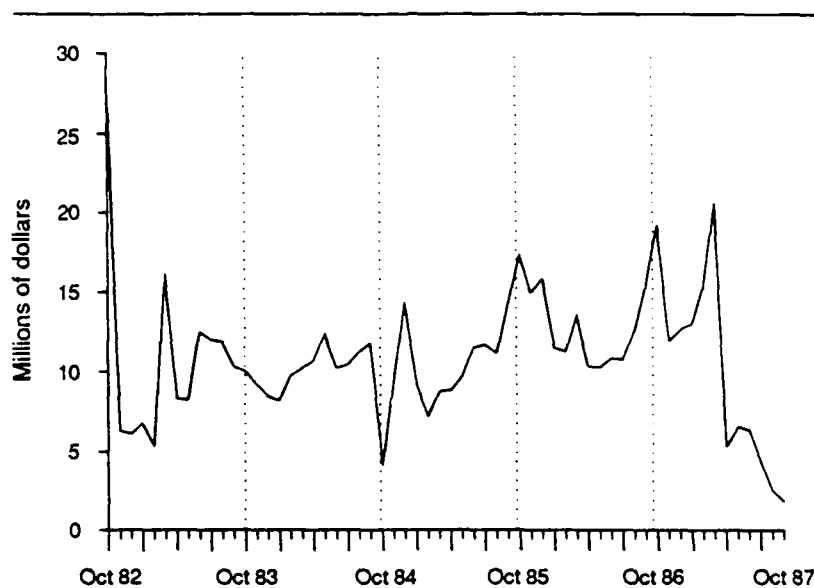


Figure 41. SRB obligations

Two figures illustrate how difficult it is to estimate the factors that drive SRB obligations. Figure 42 shows first-term reenlistments and eligibles, and figure 43 exhibits first-term reenlistment rates. The magnitude of monthly variations demonstrates the complexity involved in obtaining accurate forecasts in this area. Furthermore, the number of eligibles is not readily determined by examining EAOS dates on the enlisted master file. Personnel can reenlist at any time in the several months before their EAOS. The pool of eligibles in March 1987, for example, was not just the personnel with an EAOS in March 1987. Six-year obligors (6YOs) may decide to reenlist after four years of service or to exercise their obligated extension and decide about reenlistment at a later date. It is not clear how to handle 6YOs in the calculation of eligibles. To illustrate these difficulties, consider some of the plans produced by the SRB planners in OP-136. OP-136 produces a Phase Plan, which estimates the number of reenlistments for ratings/NECs receiving SRB, by SRB zone, on a monthly basis. The estimates are based on expected reenlistment rates and the computed number of eligibles. Table 42 compares the Phase Plan with actual data for zone totals in FY 1987. The table shows how difficult it is to estimate monthly reenlistments.

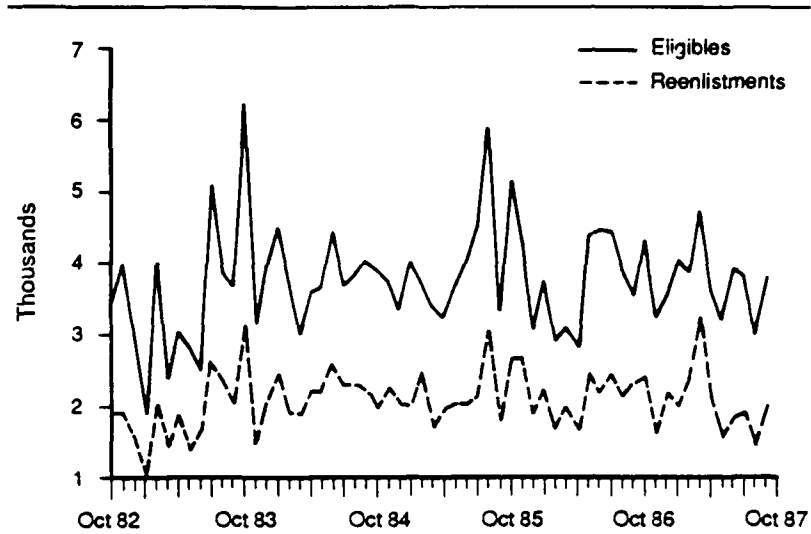


Figure 42. First-term retention (reenlistments and eligibles)

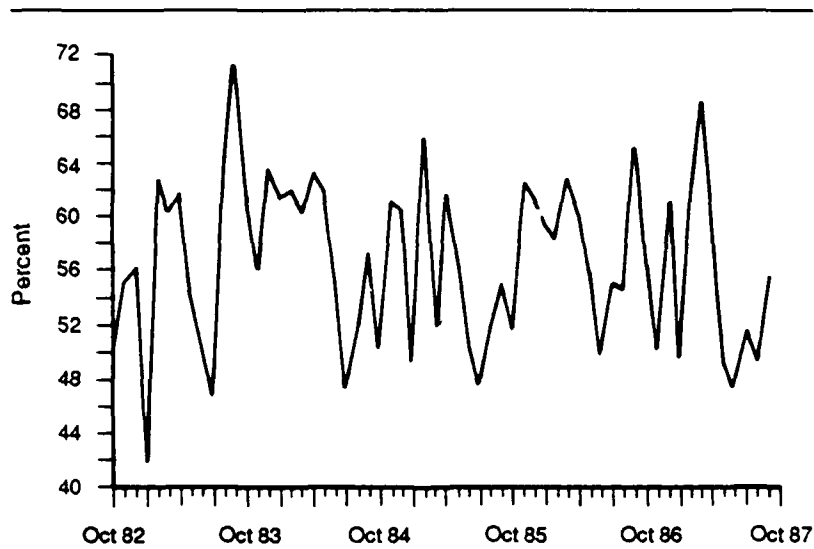


Figure 43. First-term reenlistment rates

Table 42. FY 1987 SRB reenlistments

		Zone A		Zone B		Zone C	
		Plan	Actual	Plan	Actual	Plan	Actual
Oct	1986	1,054	1,093	520	791	204	266
Nov	1986	1,100	777	552	498	223	211
Dec	1986	860	876	399	533	151	206
Jan	1987	1,048	837	500	560	186	214
Feb	1987	992	1,156	469	604	179	257
Mar	1987	627	1,622	313	836	111	302
Apr	1987	581	419	264	286	93	98
May	1987	600	529	283	373	99	223
Jun	1987	746	506	361	388	122	127
Jul	1987	811	442	405	293	122	90
Aug	1987	785	147	393	135	110	34
Sep	1987	872	164	472	87	182	17
Total		10,076	8,568	4,931	5,384	1,842	2,045

SRB payments may also differ by NEC. Thus, it is often necessary to examine finer details than rating level. For example, in analyzing the length of reenlistments of ETs, 6YO ETs must be distinguished from non-6YO ETs. Figures 44 and 45, which are graphs of reenlistment length for the two communities, show fluctuations of more than a year in average reenlistment length. Finally, figure 46 shows how award levels have varied for one community—surface warfare ETs. Although SRB award levels are obviously within the control of the Navy, their substantial fluctuations are an additional complicating factor in any attempt to analyze patterns of obligations. Award levels must be considered on an individual rating/NEC level to understand their impact on obligations.

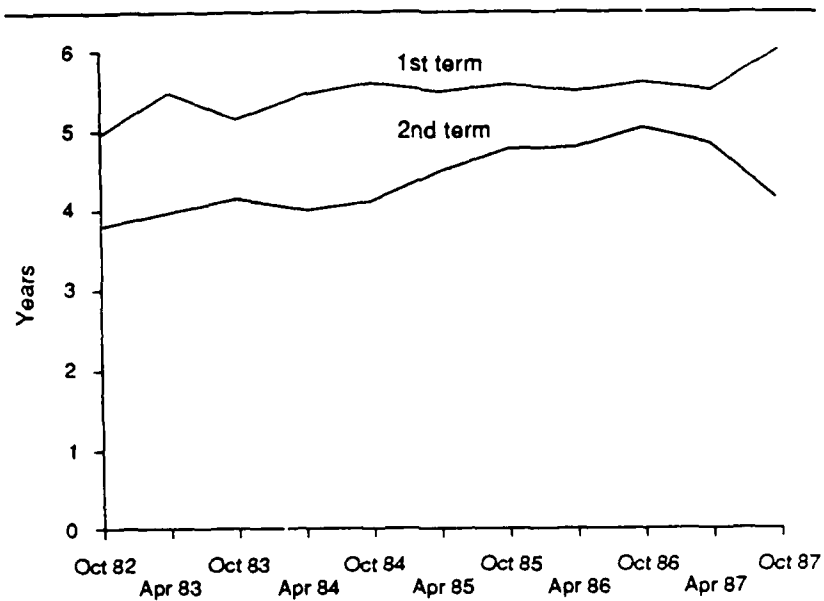


Figure 44. Average reenlistment length for 6YO ETs

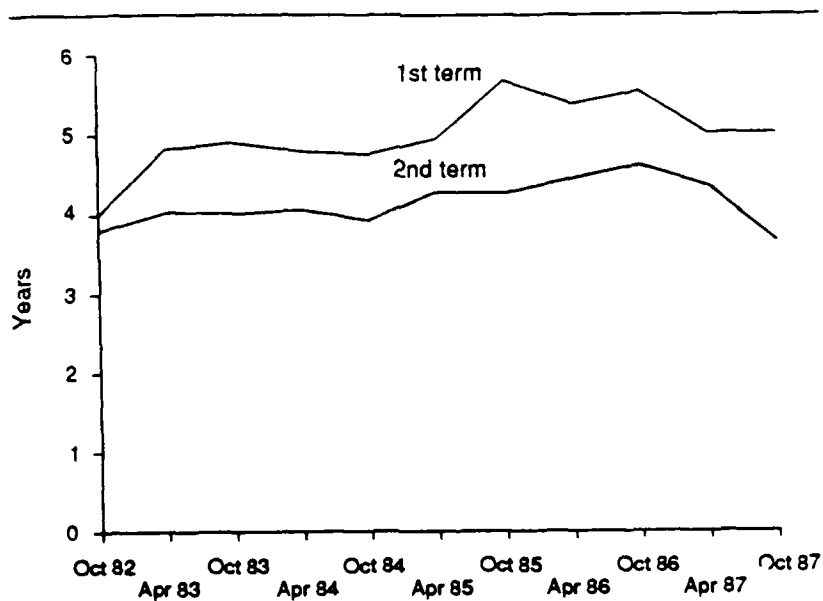


Figure 45. Average reenlistment length for non-6YO ETs

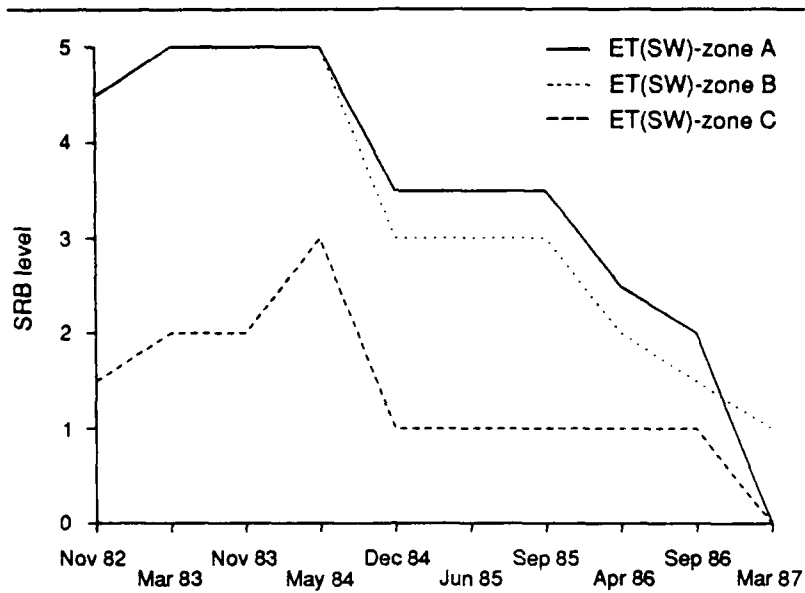


Figure 46. SRB award levels for ET(SW)

IMPLEMENTATION OF MODELS

VALIDATION OF ENLISTED BASIC PAY ESTIMATES

Strength Plan Costing

Enlisted basic pay is the largest item in the MPN account. Moreover, other pay categories may be estimated directly from information regarding enlisted basic pay. Enlisted basic pay should therefore be considered first during an effort to validate and implement the estimates that were derived above. The validation effort used the strength plans produced regularly by OP-135. Strength plans provide the force structures that underlie the many budget submissions that occur during the budget cycle and contain monthly inventories disaggregated by pay grade. With the estimation technique developed in this report, basic pay obligations can be predicted from the strength plans. In particular, a number of strength plans for FY 1987 were costed out. (FY 1987 was chosen due to the problems in MPN execution that occurred in that year.) It is hoped that the analysis explains some of the causes of difficulties in 1987. The resulting estimates of enlisted basic pay were compared with analogous data from the budget submissions that correspond to the strength plans. The results of this comparison are displayed in table 43.

Table 43. Basic pay estimates from FY 1987 strength plans

Budget submission	Date of submission	End strength	Millions of dollars		
			Budget estimate	CNA estimate (no pay raise)	CNA estimate (3 percent pay raise in Jan 1987)
FY 1987 Presidential	Jan 1986	514,548	6,136 (no pay raise)	6,153	6,292
OSD	Sep 1986	508,848	6,129 (no pay raise)	6,129	6,267
FY 1988/1989 Presidential	Jan 1987	508,598	6,228 (3 percent in Jan 1987)		6,235
NAVCOMP	Jan 1987	510,249			6,245
Actual obligations/inventory		510,026	6,247		6,243

The end-strength column reflects the changes in planned end strength that occur during a budget cycle. Obviously, such changes have an impact on obligations. During initial budget submissions, no allowance is made for a pay raise. A 3-percent pay raise in January 1987 was reflected in later budgets.

Table 43 illustrates the accuracy of the estimation methods. For example, the January 1986 budget submission contained \$6.136 billion for enlisted basic pay. The corresponding estimate was \$6.153 billion, which is a difference of \$17 million—a .28-percent margin of error. The estimation technique was even more accurate for other strength plans.

Review of FY 1987 Strength Plans

The above discussion does not address the causes of deviations from strength plans, whence budgets. Analysis of these issues begins with a review of inventories. Each strength plan contains monthly end strength figures, which can be compared with actual data. Table 44 displays such information.

The data in table 44 are revealing, although they require some explanation. They do not agree with the corresponding information in table 43. The discrepancy occurs because officer candidates are included in table 43 but not in table 44. In addition, the fact that the first two months of the January 1987 plan are precisely what occurred is because actual data were available by the time the January 1987 plan was produced.

Table 44. FY 1987 enlisted end strength—planned vs. actual

		Budget submission		Actual
		OSD plan Sep 1986	Presidential Jan 1987	
Oct	1986	503,024	502,809	502,809
Nov	1986	503,795	504,230	504,230
Dec	1986	504,487	504,662	505,296
Jan	1987	504,444	504,368	505,117
Feb	1987	504,266	505,014	505,971
Mar	1987	503,940	505,094	505,608
Apr	1987	503,513	503,826	504,948
May	1987	502,897	501,159	503,005
Jun	1987	504,819	500,630	502,590
Jul	1987	505,406	501,517	504,331
Aug	1987	506,438	504,624	507,238
Sep	1987	507,523	507,435	509,061

The January 1987 plan shows much the same end strength as the September 1986 plan, but substantial differences during the year. In particular, the January 1987 plan shows a decline in strength during the spring and early summer followed by a sharp rise in strength at the end of the fiscal year. This approach to force management was used to save money and will clearly save money if it can be successfully executed. In fact, end strength did not decline to the extent planned during the spring of 1987. It is true that this situation is complicated by the authorized raise in end strength, from 508,598 to 510,249, which occurred during the early months of 1987. However, due to fiscal constraints, the increase in authorized end strength was not properly funded, and merely exacerbated problems.

Accessions to and losses from the Navy cause variations in end strength. Accessions are to a large extent within the control of the Navy. Losses are not under Navy control and can only be influenced by pay raises, better working conditions, etc. The gains and losses data from strength plans are compared with what actually occurred in FY 1987 in tables 45 and 46.

Table 45. FY 1987 enlisted losses—planned vs. actual

	Budget submission		
	OSD plan Sep 1986	Presidential Jan 1987	Actual
Oct 1986	9,402	8,540	8,540
Nov 1986	7,517	6,309	6,309
Dec 1986	6,341	6,333	6,410
Jan 1987	7,542	7,893	7,976
Feb 1987	7,034	6,589	6,048
Mar 1987	7,197	6,913	7,791
Apr 1987	7,004	7,946	7,466
May 1987	7,300	8,684	7,741
Jun 1987	7,205	9,229	8,745
Jul 1987	9,361	8,554	8,382
Aug 1987	9,349	7,403	7,667
Sep 1987	8,857	7,692	7,406
Total	94,109	92,085	90,481

Table 46. FY 1987 enlisted gains—planned vs. actual

		Budget submission		Actual
		OSD plan Sep 1986	Presidential Jan 1987	
Oct	1986	9,044	8,155	8,155
Nov	1986	8,288	7,730	7,730
Dec	1986	7,033	6,765	7,476
Jan	1987	7,499	7,599	7,797
Feb	1987	6,856	7,235	6,902
Mar	1987	6,871	6,993	7,428
Apr	1987	6,577	6,678	6,806
May	1987	6,684	6,017	5,798
Jun	1987	9,127	8,700	8,330
Jul	1987	9,948	9,441	10,123
Aug	1987	10,381	10,510	10,574
Sep	1987	9,942	10,503	9,229
Total		98,250	96,326	96,348

The above two tables throw further light on the cause of fiscal difficulties in 1987. The January 1987 plan shows fewer planned losses than the September 1986 plan (based on experienced retention rates, etc.). Fewer total annual losses lead to increased obligations, unless one has more losses earlier in the fiscal year and many fewer losses later in the fiscal year. The January 1987 plan exhibits this method of constraining obligations, higher losses in the spring months and lower losses in the summer months, when compared to the September 1986 plan. Unfortunately, not only did the Navy not have as many losses than planned, they also did not "front load" the losses.

An analogous situation occurred with gains. The Navy saves money if it brings in accessions in the later months of a fiscal year. The January 1987 plan shows a back-loading of accessions, as well as a decline in total accessions when compared with the September 1986 plan. The actual data show that the decline in total accessions was attained, but there were problems with their back-loading.

The problem with not meeting goals for gains and losses is the cumulative impact. If someone reenlists instead of leaving the Navy, that individual will be paid in each month for the next few years. A similar consideration applies to having an excess of accessions. Thus, it is important to look at the cumulative effect of deviations in gains and losses from strength plans.

It would be hoped that a higher than expected number of losses in one month would be compensated by a lower than expected number in the next month, etc. If such compensating actions do not occur, there will be a long-term impact on fiscal obligations. Figures 47 and 48 display the cumulative deviations of the January 1987 strength plan from actual data, for losses and gains, respectively. The area between the graph and the x-axis (the zero line) represents the impact of deviations from plans on obligations. Figure 47 shows that actual cumulative losses were less than anticipated, causing increased expenditures. Similarly, cumulative accessions were consistently above planned levels, also driving up costs.

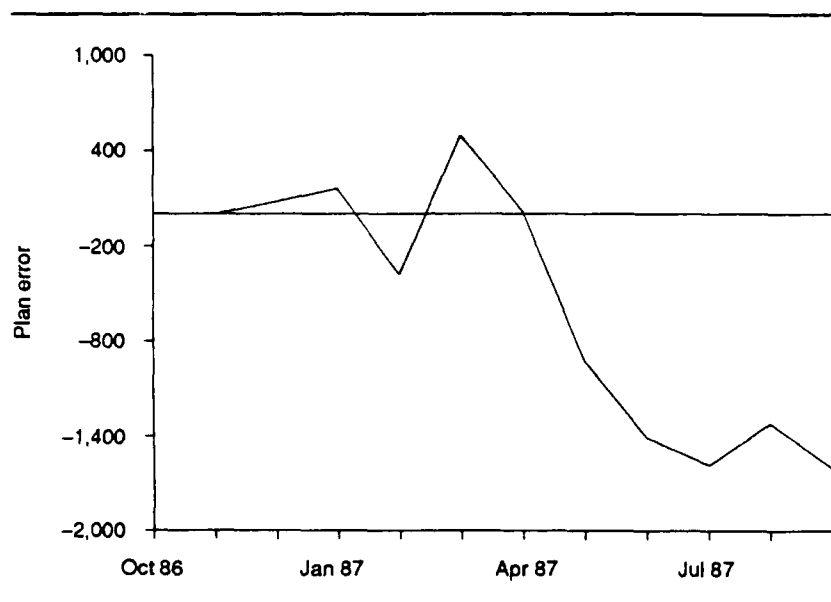


Figure 47. FY 87 loss planning accuracy (cumulative actuals minus planned)

Fiscal Impact of Deviations from Strength Plans

It is of obvious interest to Navy management to have an appreciation of the fiscal impact of deviations from strength plans. For example, end strength may be 1,000 higher than planned in a particular month, caused by fewer than anticipated losses. This will have an impact on MPN obligations for the fiscal year, but how much? By means of the techniques described above, such questions can be answered. An example will clarify things.

The FY 1987 strength plan of January 1987 provides a basic pay cost estimate of \$6.235 billion (see table 43). The strength plan anticipates 6,589 losses in February 1987. In reality, there were 6,048 losses in that February. If the strength plan is changed by that one entry and all other gains, losses, etc., are unchanged, the resulting changes in force size through the remainder of FY 1987 can be computed. This modified strength plan can be costed out. It results in an increase of \$3.3 million in obligations. Similarly, if 500 gains are added to June

accessions and 500 are subtracted from September accessions, an increase of \$1 million in obligations can be inferred.

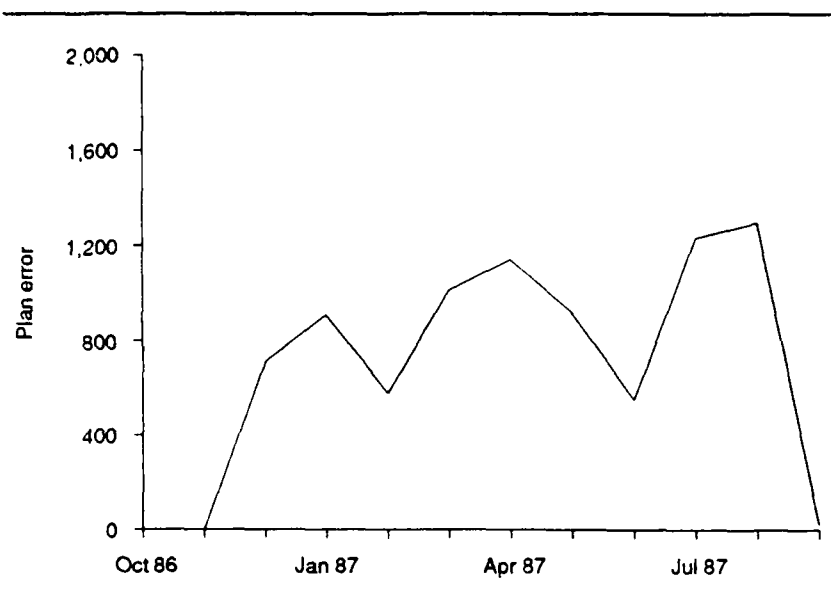


Figure 48. FY 87 gains planning accuracy (cumulative actuals minus planned)

An automated method of computing the fiscal impact of force structure variations is provided in [4], which describes some spreadsheets that estimate a variety of MPN pay categories from strength plans. In particular, these spreadsheets estimate basic pay, RPA, BAQ, and FICA for both officers and enlisted personnel, and officer BAS. The spreadsheets enable one to see the impact of variations in force structure on obligations.

ANALYSIS OF FY 1988 ENLISTED PAY OBLIGATIONS

During May 1988, enlisted basic pay obligations for FY 1988 were analyzed. The analysis provided a review of MPN execution as it was happening and supplied another way to review the accuracy of the forecast methods. Following the guidelines of the analysis of 1987 obligations, a number of strength plans were costed out. The results of this examination are displayed in table 47.

For the most part, table 47 is like table 43. At the time of the cost estimate, actual data were available for the first two quarters of FY 1988. The strength plans of April 1988 reflected this situation, having real data for the first six months of the fiscal year and planned data for the remainder. The strength plan for the entire year was costed out. This estimate may be compared with budgeted obligations to see whether execution is on track. In summary, table 47 shows that

estimated enlisted pay obligations for FY 1988 appear to be on target, given the information available as of the middle of the year.

Table 47. Enlisted basic pay estimates for FY 1988

Budget submission	Date of submission	End strength	Millions of dollars		
			Budget estimate	CNA estimate (no pay raise)	CNA estimate (2 percent pay raise in Jan 1988)
FY 1988/1989 Presidential	Feb 1987	513,725	6,398 (no pay raise)	6,375	6,471
FY 1988/1989 Presidential	Jan 1988	515,815	6,430 (2 percent in Jan 1988)		6,409
April 1988 strength plan (includes actual data to Mar 1988)	Apr 1988		6,430		6,421

It is also of interest to review the strength plans that underlie the force structure for FY 1988. The strength plans of January and April 1988 can be compared in order to understand how plans change as the year progresses. Table 48 compares end strength data from these two plans. The data from the April plan are divided in two: actual data for the first two quarters and projected strength for the remainder of the fiscal year. The January 1988 plan shows a drop in strength during the middle months of the year with a sharp rise towards the end of the year. Actual data through March 1988 show the plan being followed.

The decline in strength during the middle of FY 1988 was caused by the "early out" program in effect for this fiscal year. The impact of the program can be seen by considering the losses that correspond to the data in table 48. Table 49 contains this information and shows that the January 1988 plan anticipated a sharp rise in losses during April and May. As actual data have become available, it appears that losses began to rise in March 1988. At the time the "early out" program was initiated, the magnitude of its effect could only be accurately forecast. It appears that the program may have caused more personnel to leave the Navy than was desired.

Table 48. FY 1988 enlisted end strength

		Budget submission		
		Jan 1988 presidential	Apr 1988 actual	Apr 1988 plan
Oct	1987	509,219	509,219	
Nov	1987	509,516	509,516	
Dec	1987	508,479	508,479	
Jan	1988	508,064	508,114	
Feb	1988	507,414	507,447	
Mar	1988	507,126	506,453	
Apr	1988	500,403		500,446
May	1988	496,925		497,427
Jun	1988	501,878		502,667
Jul	1988	505,756		506,866
Aug	1988	510,353		511,786
Sep	1988	514,881		514,880

Table 49. FY 1988 enlisted losses

		Budget submission		
		Jan 1988 presidential	Apr 1988 actual	Apr 1988 plan
Oct	1987	8,087	8,353	
Nov	1987	6,983	7,195	
Dec	1987	7,309	7,516	
Jan	1988	7,973	8,145	
Feb	1988	8,053	7,859	
Mar	1988	7,596	9,304	
Apr	1988	13,438		12,876
May	1988	10,147		9,755
Jun	1988	5,468		5,250
Jul	1988	7,090		6,832
Aug	1988	6,838		6,568
Sep	1988	6,580		6,289
Total		95,562		95,942

CONCLUSIONS AND RECOMMENDATIONS

This study has investigated methods that provide Navy management with succinct and accurate forecasts of MPN obligations. The objective has been to provide tools to an individual who wants an overview of the MPN account, without too many details. The study results indicate that such a capability is available for only some of the so-called strength-related variables. In particular, reasonably accurate estimates of a variety of pay categories can be obtained based on knowledge of strength plans. The pay categories that are open to such an estimation process are basic pay, RPA, BAQ, and FICA for both officers and enlisted personnel, and officer BAS. Other pay categories exhibit too much variability to be amenable to such forecasting methods.

The value of the above estimation techniques is magnified by the size of the pay categories that are addressed. Basic pay, RPA, BAQ, and FICA account for more than 82 percent of total MPN obligations. Consequently, a large majority of the MPN account is amenable to succinct analysis.

From both practical and statistical standpoints, the estimation methods are as accurate as one can expect to obtain. The estimation techniques provide confidence intervals that are frequently less than 1 percent of obligations in span. For example, one has 95 percent confidence that a three-month forecast of enlisted basic pay will be within \$16 million of the actual value. Three months of enlisted basic pay obligations amount to approximately \$1.5 billion, which is accurate to within one-tenth of 1 percent. The complexity of the Navy's information system does not allow any greater precision. Indeed, the attained accuracy is a tribute to the viability of the methods.

The Navy needs to manage its resources very carefully because it is illegal to overexpend authorizations. Strength and budget plans should therefore err on the side of caution. It makes more sense to plan for a marginal under-obligation of authorized funds and make adjustments as the year progresses, than to plan to spend every dime that is authorized.

Navy managers may save money by varying the timing of losses, gains, and promotions. In previous years, it was a common practice for strength plans to contain some slack in promotion, accessions, and losses plans, which could be the source of money savings if necessary. Recent budget constraints, however, limit this flexibility, taking away required leeway and forcing undesirable management decisions should events not precisely follow plans. For example, the extraordinary "early out" program for FY 1988 was partially caused by the lack of more standard options, when budget restrictions caused cost cutting (strength plans already contained back-loaded accessions, etc.). As long as the Navy plans to spend every dime that is authorized and has strength plans that allow little room for maneuvering, problems with managing the execution of the MPN account can be expected to reoccur.

The study stimulated a variety of opinions regarding how the Navy could better manage the MPN account. The first opinion addresses the somewhat fragmented manner in which Navy personnel management operates. The management of the MPN account requires the knowledge and input of many organizations within OP-01 and NMPC. Historically, these organizations have operated independently and have come together only once a month in order to present a briefing to the Chief of Naval Personnel. Recent organizational changes within OP-13, toward instituting an office to coordinate the management of MPN account execution, are to be applauded. This should facilitate the pulling together of the disparate information needed in this area.

In addition, the Navy should consider the adequacy of the reports and other information that are being provided to managers of the MPN account. For example, estimation of VHA obligations is inhibited by a lack of a report that would compute such obligations from a geographical distribution of personnel and VHA rate tables. ADP support could likely be improved in a number of areas. Since ADP support involves many organizations, establishing a coordinating function within OP-13 will help bring such problems to light.

REFERENCES

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- [2] Henri Theil. *Principles of Econometrics*. Wiley, 1979
- [3] OSD Report, *Military Compensation Background Papers*, 3rd edition, Jun 1987
- [4] CNA Information Manual 26, *User's Guide to the MPN Account Management Spreadsheets*, by Mark B. Geis and David M. Rodney, Sep 1988

APPENDIX A
STRENGTH DATA

APPENDIX A

STRENGTH DATA

The following data are monthly end strengths for FY 1983 to FY 1987. The data were obtained from the officer and enlisted strength planners in OP-130 and OP-135, respectively. The data do not exactly agree with inventory counts that may be obtained from officer and enlisted master files. The strength planners' data are considered to be more accurate by OP-01 staff and are used for management purposes.

Table A-1. Monthly officer end strength

Month	O-7+	O-6	O-5	O-4	O-3	O-2	O-1	W-4	W-3	W-2	Total
Sep 1982	251	3,811	7,752	12,938	19,027	10,269	10,323	459	1,245	1,198	67,273
Oct 1982	250	3,812	7,341	12,728	18,569	10,194	10,732	459	1,252	1,293	66,630
Nov 1982	250	3,775	7,284	12,717	18,742	10,342	10,743	448	1,246	1,282	66,829
Dec 1982	248	3,739	7,261	12,694	18,631	10,430	10,719	443	1,240	1,278	66,683
Jan 1983	250	3,764	7,345	12,800	18,730	10,105	10,812	443	1,239	1,275	66,763
Feb 1983	250	3,748	7,323	12,780	18,778	10,441	10,712	437	1,237	1,274	66,980
Mar 1983	249	3,733	7,312	12,749	18,860	10,639	10,654	431	1,210	1,300	67,137
Apr 1983	250	3,760	7,429	12,787	18,707	11,015	10,341	601	1,287	1,025	67,202
May 1983	250	3,796	7,486	12,832	19,040	12,249	10,042	595	1,280	1,045	68,615
Jun 1983	248	3,821	7,572	12,695	20,632	10,559	10,453	597	1,293	1,049	68,919
Jul 1983	247	3,779	7,551	12,599	20,480	10,802	10,370	590	1,301	1,108	68,827
Aug 1983	250	3,753	7,584	12,611	20,319	10,735	10,564	590	1,304	1,151	68,861
Sep 1983	250	3,753	7,669	12,775	20,186	10,583	10,239	601	1,292	1,146	68,494
Oct 1983	252	3,701	7,580	12,820	20,281	10,614	10,443	599	1,246	1,251	68,787
Nov 1983	252	3,666	7,551	12,798	20,260	10,861	10,513	586	1,238	1,274	68,999
Dec 1983	252	3,665	7,540	12,812	20,263	10,846	10,492	580	1,233	1,305	68,988
Jan 1984	252	3,674	7,567	12,847	20,461	10,566	10,475	575	1,227	1,304	68,948
Feb 1984	252	3,685	7,599	12,890	20,349	10,901	10,308	572	1,230	1,292	69,078
Mar 1984	252	3,724	7,623	12,968	20,155	10,901	10,227	570	1,222	1,289	68,931
Apr 1984	252	3,753	7,652	13,003	20,306	10,949	9,850	714	1,356	978	68,813
May 1984	252	3,780	7,673	13,037	20,478	11,621	10,377	710	1,347	928	70,203
Jun 1984	252	3,817	7,680	13,007	21,623	11,036	9,901	701	1,336	964	70,317
Jul 1984	252	3,693	7,612	12,842	21,727	10,952	9,664	694	1,320	998	69,754
Aug 1984	252	3,685	7,630	12,827	21,696	10,722	9,647	719	1,274	1,031	69,483
Sep 1984	253	3,707	7,626	12,855	21,248	10,584	9,501	942	978	1,162	68,856
Oct 1984	252	3,682	7,777	13,136	20,889	10,578	9,799	928	983	1,223	69,247
Nov 1984	252	3,673	7,770	13,179	20,774	10,655	9,909	936	958	1,221	69,327
Dec 1984	252	3,688	7,781	13,238	20,741	10,766	9,744	935	953	1,220	69,318
Jan 1985	252	3,705	7,784	13,304	20,526	10,652	9,760	933	950	1,218	69,084
Feb 1985	252	3,711	7,775	13,354	20,382	10,721	9,894	928	946	1,211	69,174
Mar 1985	253	3,717	7,777	13,413	20,413	10,662	10,021	919	875	1,248	69,298

Table A-1. (Continued)

Month	O-7+	O-6	O-5	O-4	O-3	O-2	O-1	W-4	W-3	W-2	Total
Apr 1985	253	3,738	7,801	13,400	20,639	10,404	10,029	1,102	769	1,187	69,322
May 1985	253	3,758	7,816	13,392	21,015	11,556	10,004	1,090	749	1,232	70,865
Jun 1985	253	3,790	7,843	13,371	21,940	10,745	9,972	1,097	843	1,153	71,007
Jul 1985	253	3,738	7,834	13,261	22,116	10,397	10,109	1,105	801	1,200	70,814
Aug 1985	251	3,748	7,825	13,215	21,964	10,484	10,074	1,090	808	1,215	70,674
Sep 1985	249	3,699	7,764	13,139	22,048	10,480	10,117	1,079	843	1,239	70,657
Oct 1985	252	3,694	7,800	13,212	21,901	10,387	10,022	1,077	873	1,187	70,405
Nov 1985	252	3,686	7,785	13,216	21,795	10,389	10,201	1,067	863	1,187	70,441
Dec 1985	252	3,688	7,796	13,214	21,786	10,438	10,148	1,057	859	1,184	70,422
Jan 1986	252	3,696	7,804	13,240	21,690	10,422	10,203	1,056	843	1,184	70,390
Feb 1986	252	3,700	7,800	13,243	21,676	10,373	10,379	1,046	836	1,184	70,489
Mar 1986	252	3,710	7,794	13,243	21,716	10,285	10,665	1,044	814	1,149	70,672
Apr 1986	252	3,727	7,806	13,266	21,765	10,117	10,704	1,188	645	1,165	70,635
May 1986	252	3,747	7,818	13,293	21,856	11,637	10,802	1,179	672	1,174	72,430
Jun 1986	252	3,830	7,899	13,379	22,509	10,696	11,023	1,168	696	1,189	72,641
Jul 1986	252	3,725	7,826	13,260	22,858	10,180	10,968	1,149	716	1,213	72,147
Aug 1986	252	3,733	7,805	13,274	22,775	10,117	11,204	1,157	721	1,229	72,267
Sep 1986	251	3,709	7,765	13,382	22,433	9,687	11,695	1,125	810	1,194	72,051
Oct 1986	253	3,698	7,758	13,394	22,480	9,668	11,423	1,120	907	1,103	71,804
Nov 1986	253	3,680	7,733	13,363	22,289	9,723	11,555	1,095	910	1,085	71,686
Dec 1986	255	3,689	7,733	13,369	22,230	9,914	11,388	1,081	921	1,062	71,642
Jan 1987	255	3,703	7,750	13,402	22,245	9,773	11,400	1,068	920	1,059	71,575
Feb 1987	254	3,712	7,744	13,393	22,182	9,873	11,441	1,049	913	1,059	71,620
Mar 1987	253	3,719	7,753	13,400	22,234	9,840	11,326	1,037	890	1,061	71,513
Apr 1987	254	3,734	7,776	13,433	22,509	9,544	11,194	1,130	756	1,086	71,416
May 1987	254	3,747	7,792	13,451	22,586	10,979	11,321	1,107	779	1,088	73,104
Jun 1987	254	3,830	7,851	13,390	23,563	10,087	11,317	1,089	796	1,086	73,263
Jul 1987	256	3,718	7,800	13,264	24,063	9,561	11,188	1,065	815	1,087	72,757
Aug 1987	252	3,705	7,785	13,239	23,968	9,499	11,066	1,053	830	1,083	72,480
Sep 1987	253	3,674	7,805	13,129	23,710	9,445	11,064	1,035	855	1,081	72,051

Table A-2. Monthly enlisted end strength

Month	E-9	E-8	E-7	E-6	E-5	E-4	E-3	E-2	E-1	Total
Sep 1982	3,655	8,467	30,157	64,910	87,857	101,844	88,404	46,506	37,987	469,787
Oct 1982	3,598	8,314	29,777	64,421	87,947	101,489	93,217	44,375	42,189	475,327
Nov 1982	3,563	8,173	29,477	63,993	88,112	100,896	95,001	43,515	42,836	475,566
Dec 1982	3,557	8,119	29,376	68,310	94,424	92,802	95,082	43,178	43,665	478,513
Jan 1983	3,514	8,036	29,620	67,440	93,402	92,777	97,529	43,775	44,897	480,990
Feb 1983	3,485	7,972	29,460	67,136	92,426	92,791	100,927	44,966	39,521	478,684
Mar 1983	3,452	7,913	29,323	66,932	92,040	92,922	105,188	45,943	38,993	482,706
Apr 1983	3,415	7,830	29,124	66,553	91,402	92,855	108,069	46,938	35,301	481,487
May 1983	3,365	7,716	28,840	66,107	90,508	92,325	110,574	47,022	33,815	480,272
Jun 1983	3,864	9,180	26,523	71,506	100,672	96,118	91,909	47,524	33,608	480,904
Jul 1983	3,812	9,051	26,194	71,087	98,274	99,062	92,216	45,936	33,848	479,480
Aug 1983	3,782	8,971	30,082	66,908	96,901	103,278	91,512	45,484	33,776	480,694
Sep 1983	3,785	8,960	30,389	67,527	95,623	110,049	88,314	44,296	34,578	483,521
Oct 1983	3,721	8,746	30,293	68,006	97,277	105,164	94,043	41,052	34,334	482,636
Nov 1983	3,712	8,633	30,482	68,733	99,481	100,984	96,350	41,625	33,294	483,294
Dec 1983	3,728	8,544	30,706	69,585	101,882	99,909	96,832	38,567	33,568	483,321
Jan 1984	3,760	8,577	30,697	69,705	101,714	97,287	101,544	37,833	31,746	482,863
Feb 1984	3,820	8,673	30,762	69,948	101,951	98,315	102,173	37,020	31,781	484,443
Mar 1984	3,882	8,764	30,779	70,304	102,145	98,700	103,018	37,065	33,075	487,752
Apr 1984	3,901	8,850	30,839	70,272	102,045	99,301	103,180	37,298	32,710	488,396
May 1984	3,932	8,921	30,877	70,278	101,821	99,970	103,035	37,670	32,800	489,304
Jun 1984	3,998	9,025	30,997	74,974	100,096	100,396	100,166	38,079	35,694	493,425
Jul 1984	3,932	8,777	30,993	74,031	98,318	99,946	100,889	37,400	35,389	489,675
Aug 1984	3,950	8,668	31,163	73,307	96,843	99,786	102,888	36,990	36,308	489,903
Sep 1984	4,056	8,875	30,695	73,157	97,720	105,575	96,674	37,366	35,705	489,823
Oct 1984	4,069	8,939	30,653	73,849	97,388	103,922	97,071	37,238	34,598	487,727
Nov 1984	4,081	9,021	30,685	74,660	97,279	103,116	97,629	37,621	33,109	487,201
Dec 1984	4,126	9,125	30,781	76,588	98,033	99,645	98,107	37,861	32,553	486,819
Jan 1985	4,129	9,232	30,712	76,621	98,353	99,744	97,009	38,841	34,131	488,772
Feb 1985	4,193	9,403	30,783	76,842	98,940	100,327	96,667	40,300	31,874	489,329
Mar 1985	4,247	9,552	30,980	76,841	99,296	100,720	95,572	40,454	33,119	490,781
Apr 1985	4,295	9,718	31,207	77,031	99,889	100,835	95,308	41,077	33,279	492,639
May 1985	4,313	9,813	31,341	77,104	100,198	100,756	94,810	41,395	32,216	491,946
Jun 1985	4,342	9,829	31,554	77,228	100,349	100,499	93,835	41,585	34,250	493,471
Jul 1985	4,398	9,792	31,837	77,739	100,277	98,671	93,727	40,819	36,234	493,494
Aug 1985	4,421	9,722	31,974	78,118	99,819	96,998	95,096	40,670	36,851	493,669
Sep 1985	4,517	9,770	32,850	78,128	103,895	104,588	83,718	40,414	36,371	494,251
Oct 1985	4,501	9,749	32,525	77,850	102,567	101,910	85,410	40,250	37,530	492,292
Nov 1985	4,521	9,788	32,555	78,087	101,686	100,350	88,260	40,251	37,436	492,934
Dec 1985	4,567	9,883	32,587	78,753	101,197	99,494	90,006	40,578	37,142	494,207
Jan 1986	4,559	9,818	32,512	78,490	101,543	99,567	89,857	41,826	36,574	494,746
Feb 1986	4,578	9,870	32,549	78,453	102,174	100,157	89,149	42,576	36,339	495,845
Mar 1986	4,619	9,953	32,418	78,728	102,951	101,457	87,954	43,540	34,620	496,240
Apr 1986	4,659	10,066	32,259	78,508	103,695	102,672	87,058	43,834	33,042	495,793
May 1986	4,671	10,087	32,073	78,145	104,127	103,713	86,609	44,101	30,228	493,754

Table A-2. (Continued)

Month	E-9	E-8	E-7	E-6	E-5	E-4	E-3	E-2	E-1	Total
Jun 1986	4,676	10,149	31,941	79,211	104,474	103,850	84,041	44,122	31,950	494,414
Jul 1986	4,704	10,091	31,994	79,252	103,431	104,835	84,275	43,508	34,697	496,787
Aug 1986	4,753	10,031	32,634	78,805	102,465	105,983	84,032	43,181	38,029	499,913
Sep 1986	4,807	10,009	33,311	78,930	102,193	107,668	83,871	42,462	39,943	503,194
Oct 1986	4,747	9,962	33,246	78,724	103,112	106,480	84,397	42,055	40,086	502,809
Nov 1986	4,757	10,010	33,357	78,798	104,195	105,514	84,017	42,046	41,536	504,230
Dec 1986	4,795	10,034	33,428	79,109	105,582	105,427	84,427	42,043	40,451	505,296
Jan 1987	4,716	9,933	33,561	78,490	104,819	103,957	86,567	43,452	39,622	505,117
Feb 1987	4,670	9,875	33,856	77,967	104,248	103,383	89,519	44,877	37,576	505,971
Mar 1987	4,627	9,815	33,717	77,697	103,652	102,953	92,791	47,220	33,136	505,608
Apr 1987	4,578	9,789	33,613	77,430	102,869	102,332	95,129	47,995	31,213	504,948
May 1987	4,546	9,798	33,635	77,092	101,851	101,100	96,387	48,471	30,124	503,005
Jun 1987	4,676	10,186	32,616	81,575	104,077	105,109	84,136	48,879	31,336	502,590
Jul 1987	4,593	10,087	32,460	81,069	102,724	104,648	86,254	48,055	34,441	504,331
Aug 1987	4,531	10,009	34,395	78,568	101,756	104,430	90,187	46,796	36,566	507,238
Sep 1987	4,619	10,395	33,743	80,817	102,128	107,729	86,505	45,773	37,352	509,061

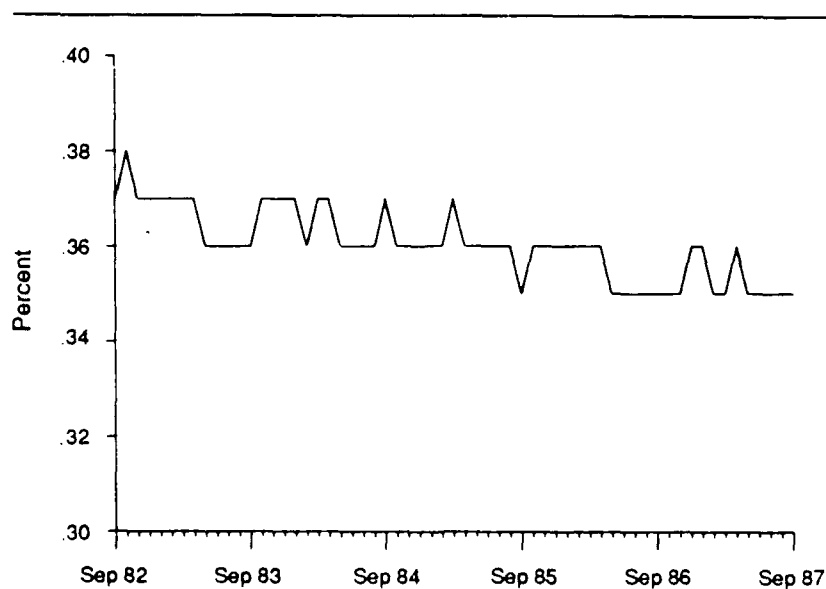


Figure A-1. 0-7s to 0-10s as a percentage of officers

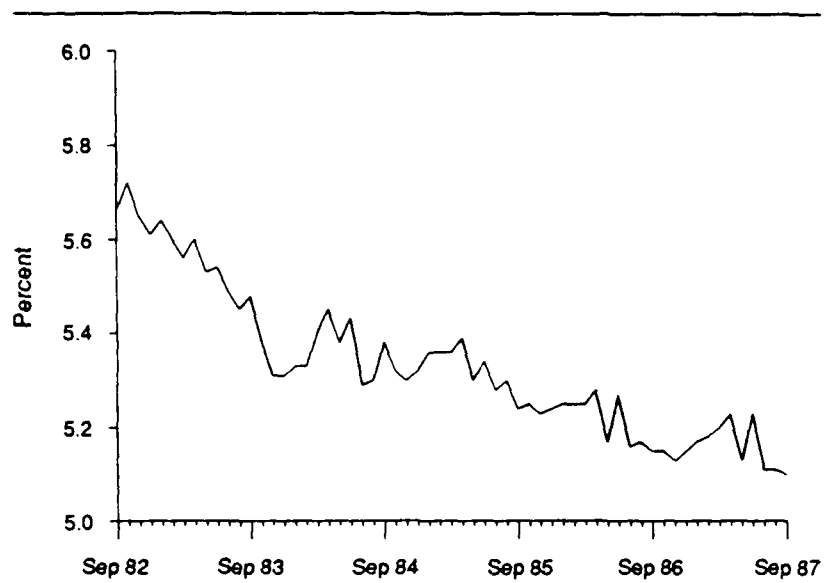


Figure A-2. 0-6s as a percentage of officers

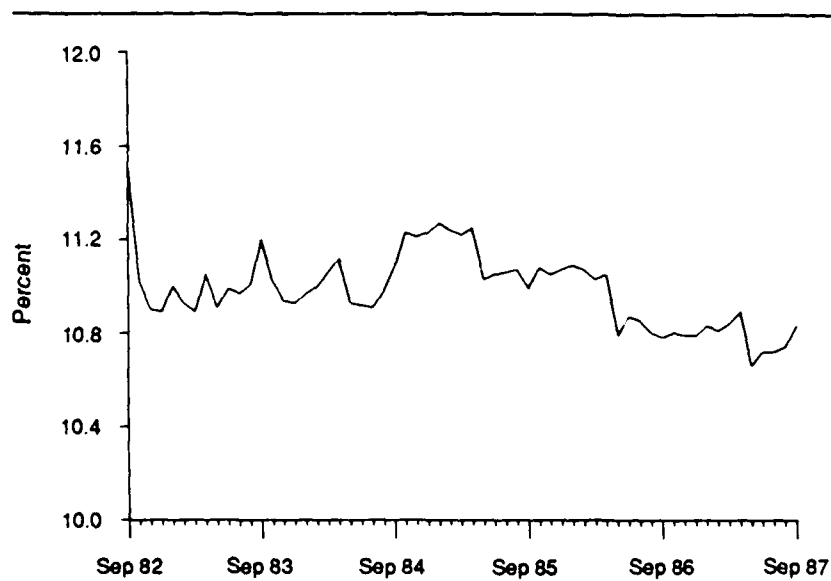


Figure A-3. 0-5s as a percentage of officers

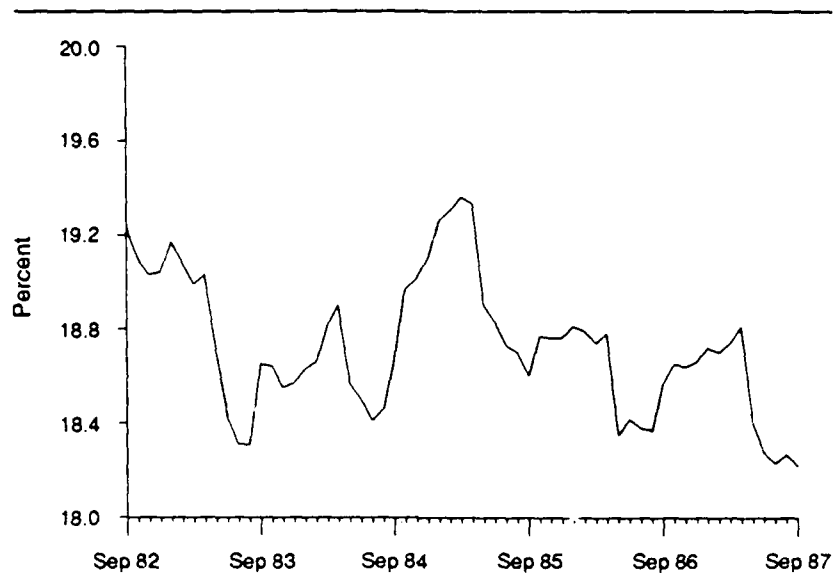


Figure A-4. 0-4s as a percentage of officers

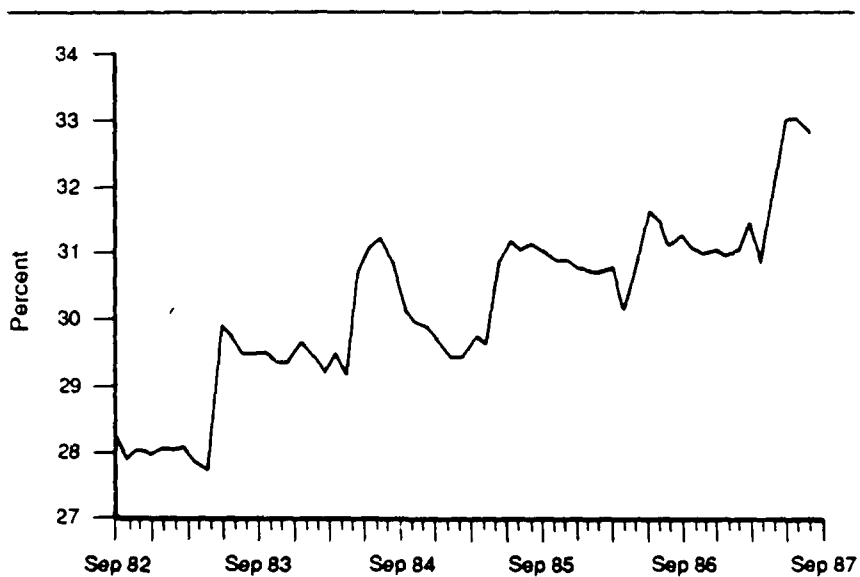


Figure A-5. 0-3s as a percentage of officers

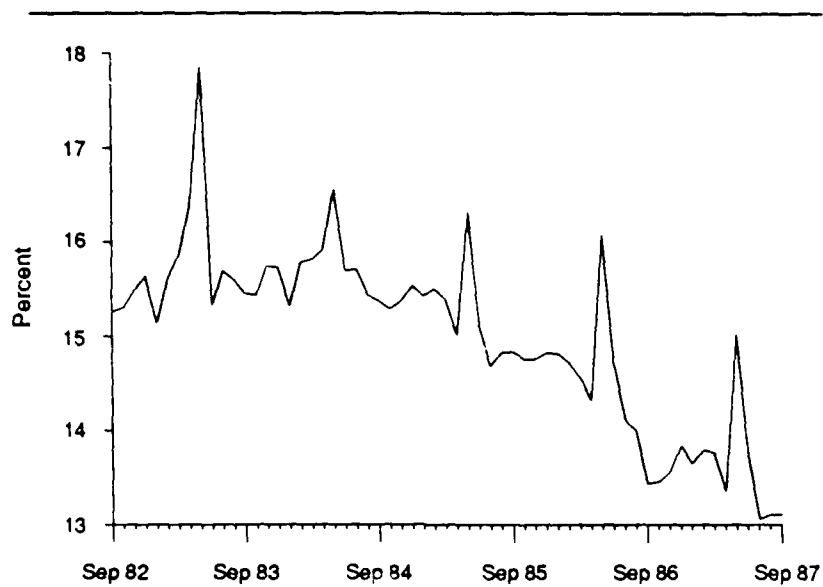


Figure A-6. 0-2s as a percentage of officers

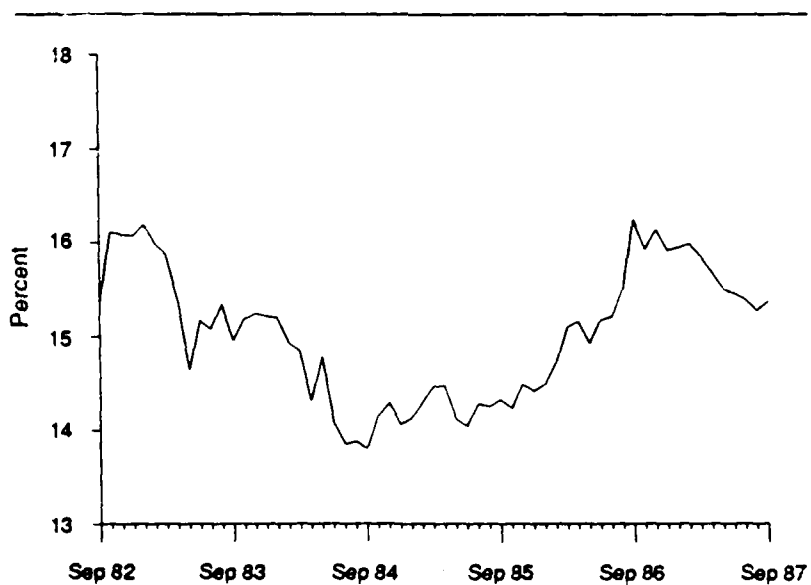


Figure A-7. 0-1s as a percentage of officers

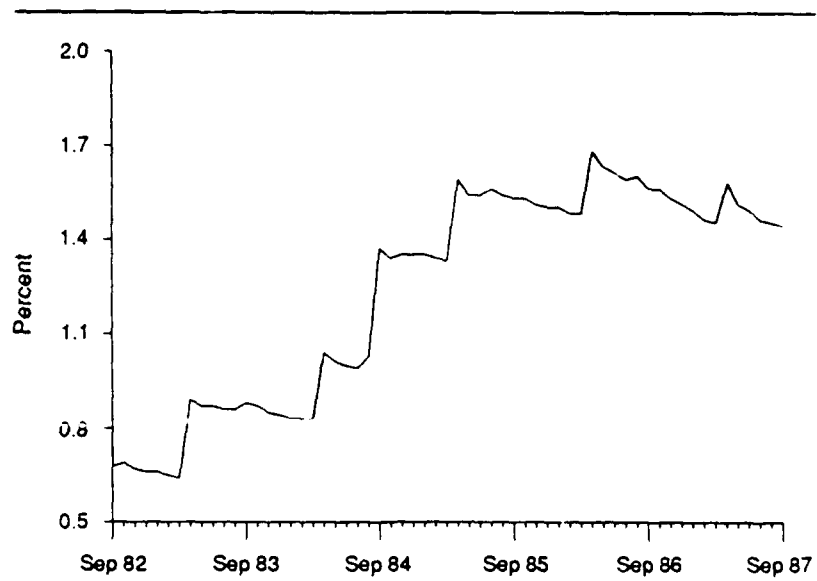


Figure A-8. W-4s as a percentage of officers

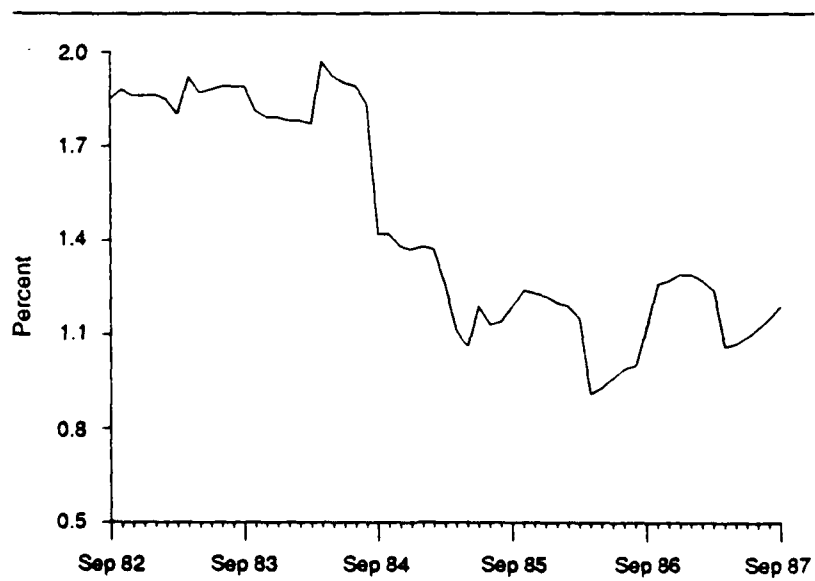


Figure A-9. W-3s as a percentage of officers

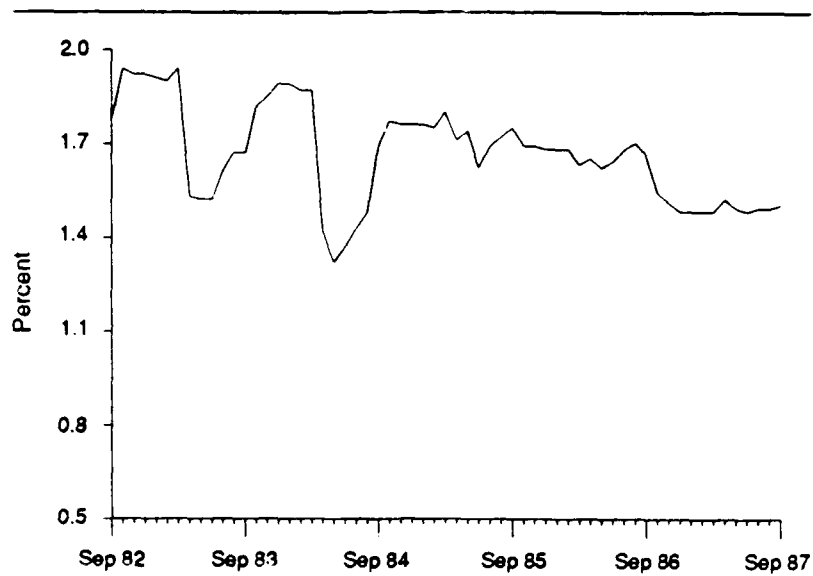


Figure A-10. W-2s as a percentage of officers

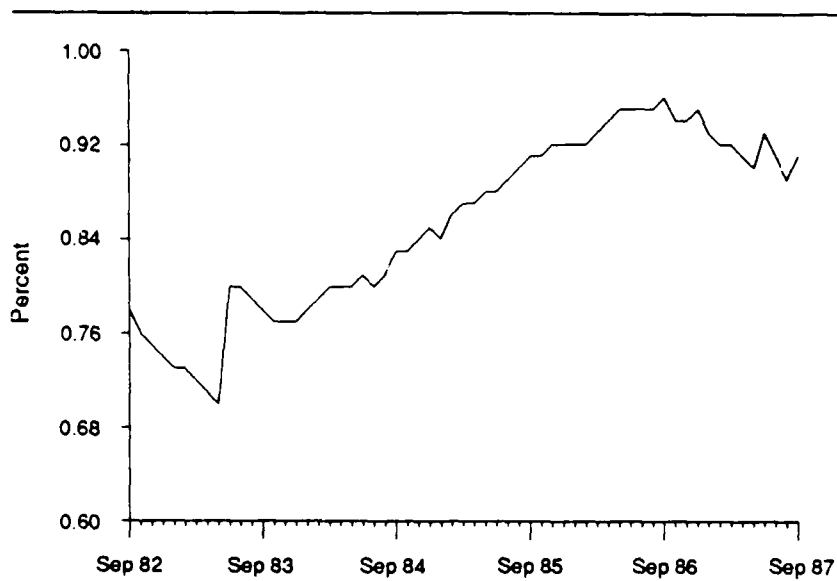


Figure A-11. E-9s as a percentage of enlisted

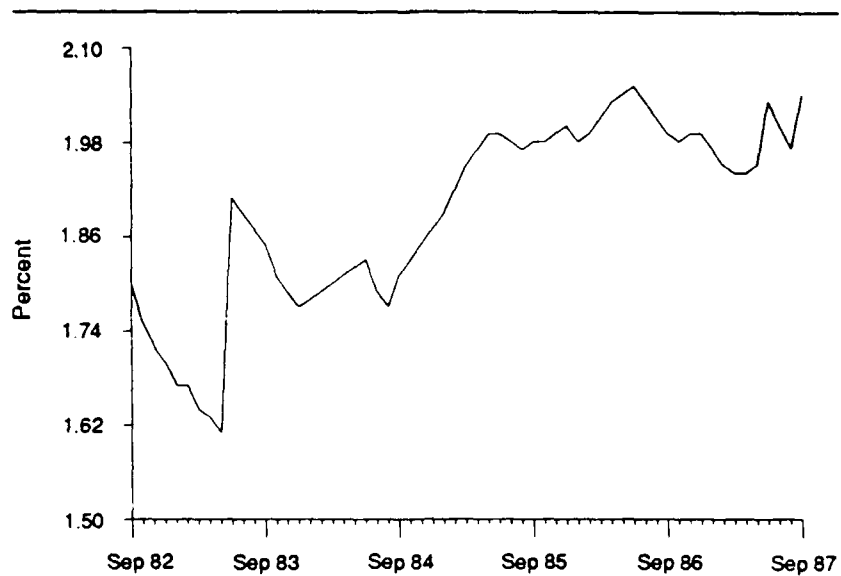


Figure A-12. E-8s as a percentage of enlisted

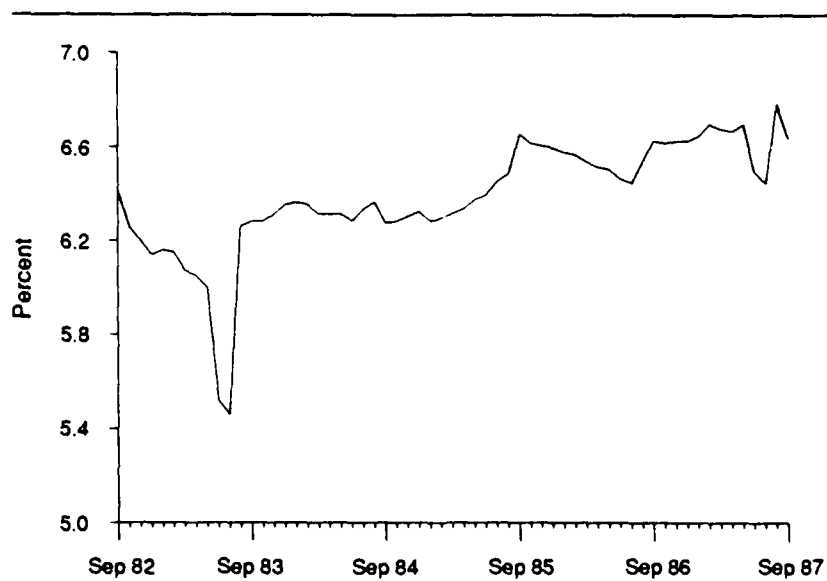


Figure A-13. E-7s as a percentage of enlisted

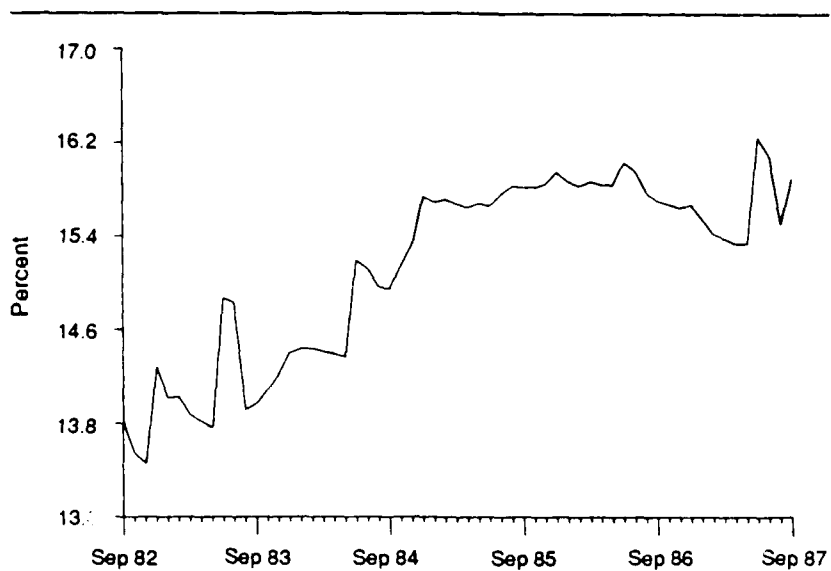


Figure A-14. E-6s as a percentage of enlisted

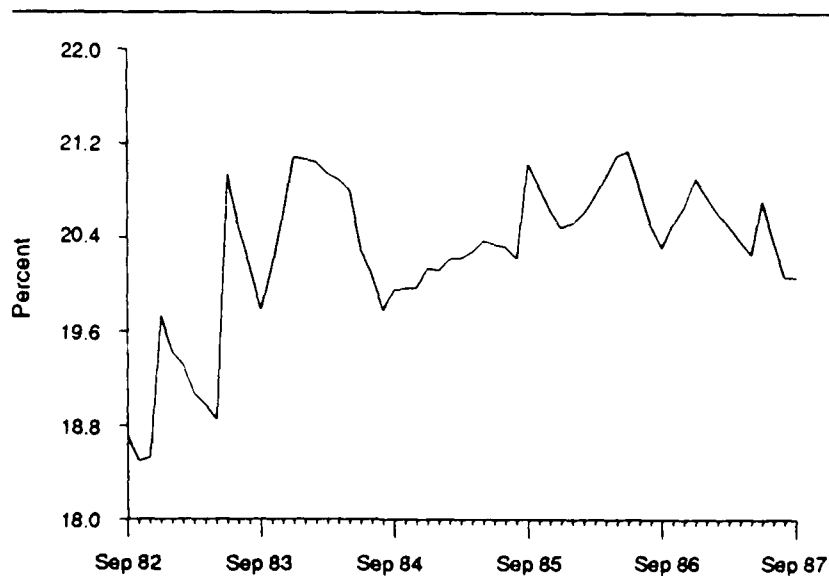


Figure A-15. E-5s as a percentage of enlisted

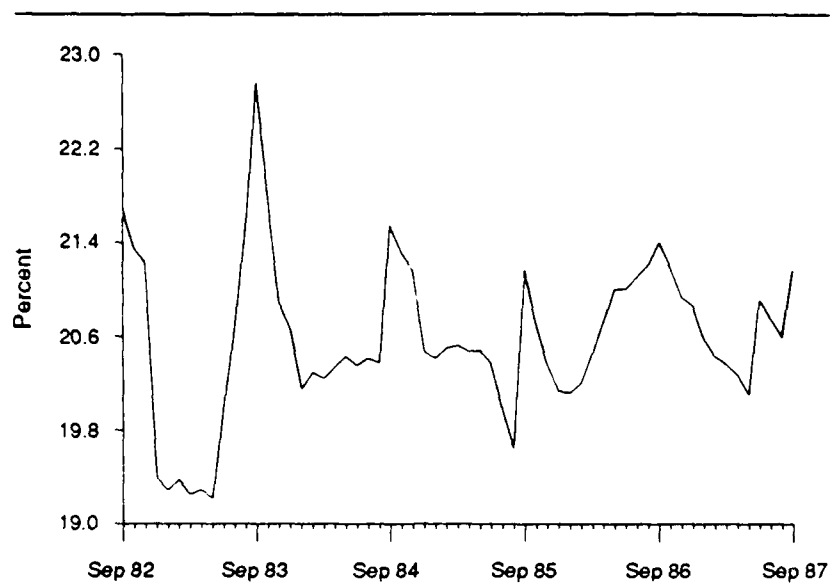


Figure A-16. E-4s as a percentage of enlisted

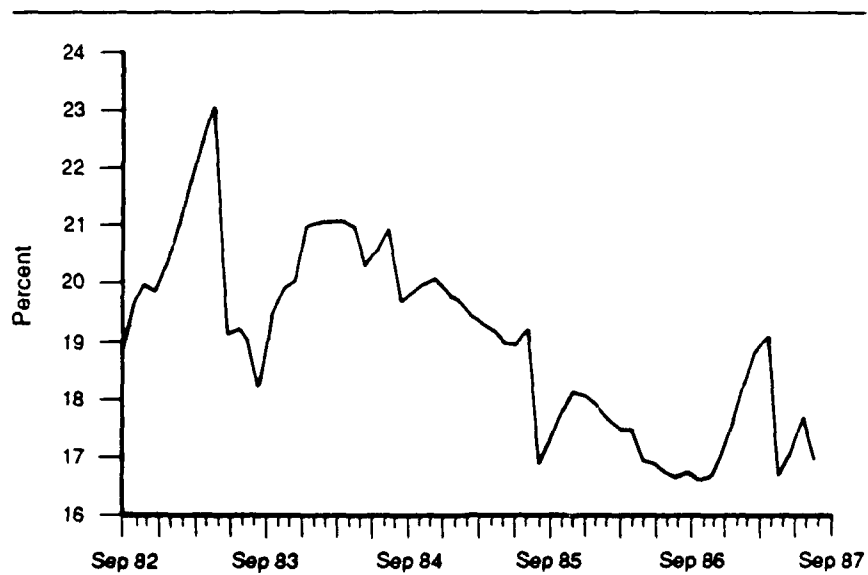


Figure A-17. E-3s as a percentage of enlisted

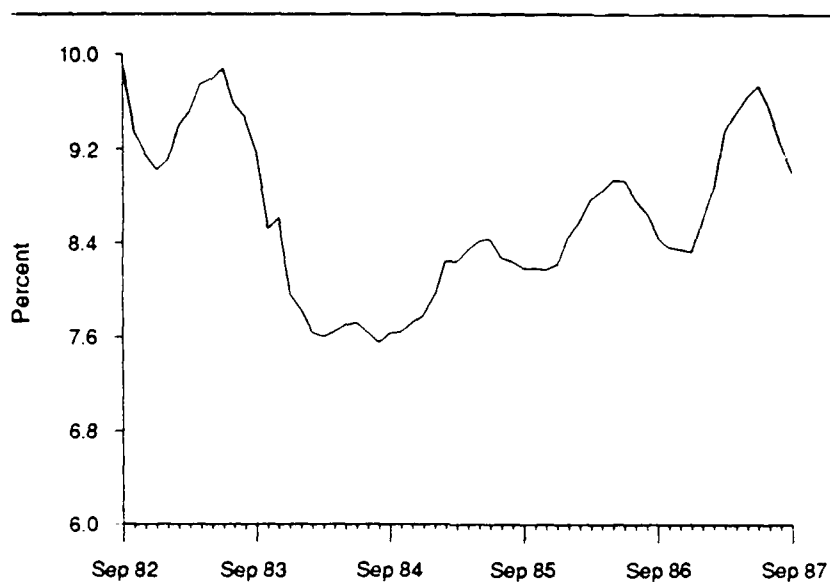


Figure A-18. E-2s as a percentage of enlisted

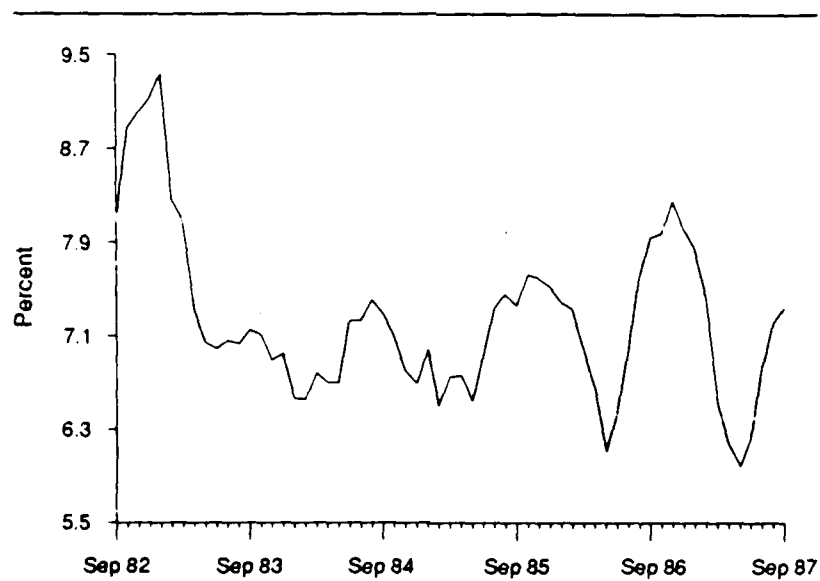


Figure A-19. E-1s as a percentage of enlisted

APPENDIX B
OBLIGATION DATA

APPENDIX B

OBLIGATION DATA

The following data are monthly MPN obligations for FY 1983 to FY 1987 as reported on NAVCOMPT Form 2158 (Revision 5-74). The data were obtained from NMPC-7.

Table B-1. Monthly officer MPN obligations (in thousands of dollars)

	Basic pay	RPA	Incentive pay	Special pay	BAQ	VHA	BAS	Over- seas station	Uniform allow- ance	Family sepa- ration	Seperation pay- ments	FICA	Total
Oct 1982	145,027		11,082	10,199	20,774	7,784	6,602	1,401	259	160	1,582	8,739	287,138
Nov 1982	139,268		7,940	5,140	20,136	8,116	6,498	1,801	139	189	1,529	8,260	267,625
Dec 1982	146,146		6,978	2,565	20,392	7,323	6,574	896	54	120	3,889	7,001	276,036
Jan 1983	140,960		6,782	4,823	21,082	5,819	6,603	2,676	73	122	53	10,337	270,797
Feb 1983	139,296		5,124	7,105	20,472	5,933	6,605	982	99	197	3,001	9,660	269,097
Mar 1983	142,800		5,912	5,187	20,665	6,109	6,655	1,372	84	138	639	9,702	271,663
Apr 1983	144,419		7,483	6,162	20,733	6,537	6,553	2,060	117	207	548	9,694	277,733
May 1983	144,448		9,297	5,561	21,928	7,186	6,629	1,706	739	193	-322	9,493	280,093
Jun 1983	148,795		2,789	8,691	21,778	6,753	6,876	3,219	504	145	4,053	10,016	289,058
Jul 1983	147,115		19,147	27,437	21,716	6,933	6,747	1,558	-389	182	1,943	10,353	317,329
Aug 1983	149,724		10,302	7,629	21,744	6,852	6,822	2,275	78	160	2,982	9,851	294,329
Sep 1983	146,046		10,033	14,461	19,999	7,079	6,697	794	68	176	2,226	9,921	291,543
Oct 1983	146,669		10,163	10,078	21,317	6,751	6,772	1,698	173	165	1,948	9,245	289,780
Nov 1983	148,151		6,367	5,625	21,523	6,901	6,819	2,494	371	165	1,501	9,036	284,510
Dec 1983	146,094		6,790	5,140	21,400	6,614	6,765	1,913	56	161	2,977	8,350	280,768
Jan 1984	152,665		9,946	6,176	22,115	6,073	7,009	1,780	-116	148	3,072	10,759	297,486
Feb 1984	152,135		7,560	5,781	22,087	6,108	7,030	1,621	95	160	-1,152	10,661	289,685
Mar 1984	148,058		8,843	4,590	21,803	6,464	6,938	1,791	45	225	1,266	10,675	286,208
Apr 1984	153,588		5,333	5,076	22,210	5,928	7,034	2,007	70	158	1,890	10,825	292,349
May 1984	156,888		7,144	6,335	23,249	6,577	6,965	1,863	374	159	1,373	13,719	304,659
Jun 1984	160,747		8,630	9,750	23,007	6,318	8,189	2,289	177	87	2,986	9,135	313,296
Jul 1984	158,820		12,760	27,364	21,792	4,965	5,996	2,051	169	233	3,991	10,285	329,424
Aug 1984	160,579		10,284	6,527	25,603	6,974	8,088	2,057	58	98	2,765	11,554	316,482
Sep 1984	142,074		9,691	18,138	19,550	5,184	6,069	2,329	40	182	3,278	10,360	289,353
Oct 1984	154,054	78,827	8,929	10,697	22,542	6,068	7,077	1,908	262	151	2,611	10,181	303,307
Nov 1984	153,442	78,823	7,175	5,292	22,420	6,108	6,872	1,988	167	141	2,055	9,994	294,477
Dec 1984	153,299	79,063	6,504	4,613	22,458	6,055	7,120	2,028	-34	203	1,942	9,399	292,650
Jan 1985	159,952	81,686	8,167	6,138	23,097	8,749	7,243	2,220	89	213	5,292	11,407	314,253
Feb 1985	158,274	81,733	6,926	5,275	23,289	8,694	7,455	2,160	136	43	2,718	11,365	308,068
Mar 1985	157,982	81,691	8,888	5,575	22,747	8,949	7,271	1,910	120	240	-296	11,382	306,259
Apr 1985	164,942	84,090	9,068	5,473	23,681	8,913	7,544	2,097	97	140	2,802	11,964	320,811
May 1985	160,352	82,360	7,046	5,287	22,084	7,907	7,147	1,761	465	148	120	10,917	305,594
Jun 1985	167,743	86,129	7,189	8,790	23,749	8,914	7,483	2,291	227	166	1,762	11,748	326,191
Jul 1985	163,296	83,944	8,291	28,424	24,554	8,664	7,474	2,132	164	113	6,049	11,675	344,780
Aug 1985	161,303	83,549	8,586	8,404	24,083	9,182	7,514	2,519	129	141	1,944	11,595	318,949
Sep 1985	162,159	75,100	8,614	17,456	23,479	9,074	7,491	2,138	237	158	3,338	11,487	320,731
Oct 1985	162,694	83,039	7,330	9,709	23,541	8,988	7,511	2,368	93	214	2,139	11,145	318,771
Nov 1985	173,024	87,627	5,572	4,535	24,821	10,035	7,911	2,172	166	571	3,157	11,213	330,804
Dec 1985	171,887	87,396	6,887	5,856	24,292	9,413	7,693	2,325	26	24	3,476	10,347	329,622
Jan 1986	169,727	86,376	8,048	7,058	24,516	9,521	7,717	2,237	133	308	2,028	12,112	329,781
Feb 1986	163,785	84,137	7,730	3,907	24,222	9,683	7,699	2,875	146	91	1,059	12,129	317,463
Mar 1986	166,592	83,930	8,109	10,083	24,740	9,481	7,678	2,597	199	402	1,166	12,099	327,076
Apr 1986	173,331	88,112	8,614	5,585	24,367	8,869	7,724	2,623	-20	294	1,253	12,147	332,899
May 1986	168,924	86,007	7,108	6,401	24,521	8,971	7,768	2,727	540	234	1,042	12,240	326,483
Jun 1986	166,233	85,332	6,801	8,736	25,266	9,362	7,972	3,127	353	302	2,313	12,488	328,285
Jul 1986	172,352	86,744	8,214	28,987	25,007	9,844	7,921	3,329	71	481	6,271	12,430	361,431
Aug 1986	171,826	71,227	6,965	7,958	24,949	9,473	7,932	3,291	112	296	868	12,326	317,253
Sep 1986	168,987	71,702	6,997	14,958	24,968	9,468	7,897	3,134	167	264	3,454	12,293	324,269
Oct 1986	171,761	89,885	7,059	8,937	24,922	9,435	8,121	3,067	167	300	1,694	12,283	337,631
Nov 1986	170,841	89,359	6,831	6,137	24,835	9,454	7,883	3,393	90	364	5,410	11,438	336,035
Dec 1986	169,699	89,405	7,333	7,457	24,692	9,257	7,860	2,276	54	293	2,437	11,072	331,835
Jan 1987	174,838	91,231	7,156	7,717	25,621	9,560	8,050	3,176	180	194	3,342	12,518	343,583
Feb 1987	175,854	92,190	7,860	7,264	26,013	10,154	7,870	1,649	181	-390	614	12,466	341,725
Mar 1987	174,935	91,495	7,674	9,502	25,811	10,242	8,089	3,552	150	292	1,123	12,688	345,353
Apr 1987	173,606	91,414	8,463	7,106	25,628	9,844	8,037	3,203	102	259	2,256	12,635	342,553
May 1987	176,234	92,112	10,522	7,198	25,897	9,904	8,147	3,772	476	272	1,638	12,592	348,764
Jun 1987	179,823	94,076	9,271	8,559	25,855	10,063	8,223	4,922	230	327	1,947	12,935	356,231
Jul 1987	175,516	94,188	6,218	27,432	26,271	10,079	8,225	4,115	33	719	3,157	12,903	368,856
Aug 1987	176,684	92,873	7,454	9,363	25,476	9,727	8,216	3,475	108	279	2,579	12,891	349,123
Sep 1987	177,927	91,122	9,367	10,900	26,243	9,932	8,053	2,434	8	591	5,619	12,304	354,500

Table B-2. Monthly enlisted MPN obligations (in thousands of dollars)

	Basic pay	RPA	Incentive pay	Special pay	Special duty	SRB	Enlistment bonus	BAQ	VHA	Over- seas station	Clothing allowance	Family separation	Seperation payments	FICA	Total
Oct 1982	412,688		6,291	15,982	1,658	36,984	1,367	52,395	18,563	5,649	8,095	879	6,893	27,799	803,356
Nov 1982	420,791		6,502	15,928	1,637	11,024	1,353	57,280	19,269	5,407	8,422	1,273	6,080	28,483	796,770
Dec 1982	422,959		6,189	16,020	1,669	1,274	867	54,779	19,326	6,076	8,617	711	4,498	28,153	786,578
Jan 1983	424,800		5,836	19,801	1,984	17,117	799	56,787	19,502	6,062	7,562	928	4,745	28,645	809,982
Feb 1983	422,995		6,146	19,695	1,733	4,320	1,152	56,597	19,374	6,083	7,798	1,295	5,241	28,378	795,281
Mar 1983	421,928		5,142	18,555	1,795	20,600	2,422	56,327	19,054	6,629	7,592	861	5,204	28,312	810,336
Apr 1983	427,887		6,427	17,493	1,850	12,016	639	56,862	19,014	6,523	7,305	1,284	5,967	28,980	808,986
May 1983	431,718		6,356	17,648	1,852	12,403	74	56,866	19,885	7,513	7,721	1,189	5,185	28,897	815,970
Jun 1983	421,710		6,593	18,861	1,969	15,376	665	56,326	19,661	6,351	7,348	1,340	5,237	28,230	803,506
Jul 1983	429,958		6,626	17,312	1,912	13,496	640	59,331	20,612	6,217	7,640	868	6,404	28,887	817,894
Aug 1983	422,577		6,229	19,180	1,968	6,361	-468	57,355	19,732	7,168	8,929	1,041	6,492	28,710	799,553
Sep 1983	440,868		6,435	20,695	1,886	12,642	1,128	57,682	20,068	6,404	8,641	1,085	5,292	29,644	835,988
Oct 1983	429,593		6,554	18,412	1,744	14,900	640	58,717	20,205	6,808	7,773	1,098	6,886	28,921	821,341
Nov 1983	425,751		6,399	19,659	1,867	18,911	1,136	57,515	20,501	7,121	8,121	1,171	5,632	8,647	819,584
Dec 1983	432,538		6,419	18,337	1,787	11,934	1,140	59,668	20,429	7,140	8,018	1,304	5,583	29,000	823,901
Jan 1984	448,243		6,253	19,873	1,940	17,833	565	62,068	18,743	6,419	8,849	813	5,581	31,377	857,171
Feb 1984	447,725		6,295	19,065	2,032	17,699	1,302	61,305	18,289	6,683	8,279	728	5,362	31,635	854,739
Mar 1984	445,345		6,844	18,910	1,726	14,579	6,327	60,721	17,415	7,697	9,052	1,294	6,231	30,943	854,212
Apr 1984	450,534		7,026	20,302	2,024	17,455	-4,551	62,252	20,736	8,133	8,223	1,182	2,567	31,627	857,282
May 1984	454,834		6,908	21,021	2,330	17,134	4,232	61,972	19,159	7,002	8,764	1,167	5,745	31,936	874,189
Jun 1984	454,378		6,240	18,969	1,450	15,976	-2,537	62,570	18,012	7,239	9,465	1,142	6,662	32,568	863,867
Jul 1984	461,660		5,579	19,348	1,953	6,897	1,110	62,172	18,530	6,851	8,884	1,121	4,515	31,925	865,992
Aug 1984	458,647		6,049	20,632	2,320	15,398	1,110	62,640	19,067	6,406	8,632	1,159	6,217	31,420	875,607
Sep 1984	444,598		6,681	19,781	1,629	14,229	636	63,798	19,401	7,368	7,726	1,090	6,358	33,032	853,072
Oct 1984	456,952	232,690	6,741	19,867	1,870	34,587	925	62,575	18,975	8,245	9,036	1,217	6,811	32,127	892,418
Nov 1984	451,864	230,232	5,991	19,249	1,929	15,079	925	63,802	18,967	8,168	8,743	561	5,062	31,779	880,341
Dec 1984	452,599	230,798	6,432	19,491	2,141	22,059	925	63,302	20,349	7,285	7,081	1,542	4,928	31,517	870,437
Jan 1985	478,800	244,031	6,621	19,291	1,900	16,091	925	67,302	24,803	8,405	8,876	1,138	6,073	34,287	918,543
Feb 1985	475,578	242,806	6,253	20,848	2,079	13,798	925	67,509	25,101	6,947	8,850	880	7,678	33,159	912,391
Mar 1985	477,095	244,474	6,498	21,410	2,181	18,422	925	68,189	24,335	4,767	7,487	1,359	5,687	34,032	916,859
Apr 1985	489,232	247,744	7,166	18,866	2,372	14,974	925	68,437	24,277	6,899	10,005	1,034	5,509	34,481	931,731
May 1985	483,118	245,625	6,059	20,689	3,057	14,900	925	68,420	24,208	6,681	8,685	1,347	151	33,777	917,620
Jun 1985	476,915	243,089	6,748	19,902	2,905	16,586	925	68,281	24,878	5,623	8,577	1,014	7,300	33,639	916,340
Jul 1985	481,044	245,065	6,748	19,798	3,118	16,986	925	68,621	23,136	6,263	9,767	542	5,559	34,163	921,734
Aug 1985	475,740	242,942	7,333	20,026	2,510	14,438	925	67,651	23,124	7,389	9,467	1,361	9,413	33,790	916,109
Sep 1985	481,258	236,920	7,178	20,161	2,932	20,056	925	67,743	24,462	7,121	10,427	1,083	6,331	33,981	920,577
Oct 1985	482,530	245,338	7,046	19,680	2,818	56,555	1,008	68,530	24,937	7,276	5,146	1,310	6,272	34,207	962,653
Nov 1985	514,068	260,794	8,340	20,026	2,789	25,512	885	72,801	27,040	6,883	6,129	3,202	4,578	36,389	989,396
Dec 1985	498,440	251,968	7,427	19,412	2,996	18,261	1,736	70,924	25,518	9,445	6,783	1,500	3,981	36,121	961,489
Jan 1986	498,367	251,088	6,775	20,055	2,945	28,741	424	69,814	23,830	8,911	3,295	1,718	7,583	35,735	967,281
Feb 1986	504,203	258,162	7,871	20,407	4,422	18,278	256	73,173	27,612	7,721	7,453	2,109	5,244	36,982	972,893
Mar 1986	496,368	251,478	7,146	20,178	4,599	22,516	642	71,475	17,924	9,015	6,379	3,030	8,534	35,379	964,661
Apr 1986	507,480	257,483	6,921	20,948	5,324	16,195	1,730	71,736	30,682	9,513	6,332	1,900	918	36,385	973,547
May 1986	502,202	254,959	7,854	20,864	3,085	16,036	-126	72,033	24,276	10,331	5,864	2,156	7,667	37,348	964,545
Jun 1986	498,275	254,951	7,801	21,233	3,612	3,546	877	72,447	24,425	9,328	11,473	2,830	5,949	34,626	962,377
Jul 1986	498,362	253,263	7,811	20,144	4,000	16,212	-185	72,134	23,273	9,925	10,834	3,137	6,341	36,174	961,445
Aug 1986	508,775	211,786	7,568	21,870	4,049	15,577	1,168	72,402	20,285	10,655	12,542	2,210	7,271	36,501	930,639
Sep 1986	503,265	211,498	8,273	22,196	4,317	18,420	547	72,381	21,994	9,754	16,153	1,376	5,477	35,584	931,215
Oct 1986	508,803	266,733	7,789	20,827	4,428	57,322	1,509	71,916	22,773	10,262	11,876	2,562	7,020	36,448	1,029,256
Nov 1986	514,146	267,677	7,591	21,963	4,609	28,765	-1,194	73,445	23,964	10,062	11,640	2,302	5,864	36,701	1,007,525
Dec 1986	514,265	268,198	7,861	20,668	3,825	30,962	2,023	73,512	24,688	9,362	10,202	1,623	5,589	34,644	1,007,670
Jan 1987	523,156	272,716	7,056	20,529	4,260	16,480	815	75,231	24,124	9,120	14,995	1,980	4,638	37,239	1,012,319
Feb 1987	524,273	273,263	7,500	22,588	4,374	21,034	298	74,142	24,031	8,987	9,804	1,928	4,566	37,305	1,014,063
Mar 1987	528,161	275,334	8,356	21,106	4,604	28,324	591	76,408	25,489	10,752	4,656	2,800	5,637	37,450	1,029,758
Apr 1987	527,223	273,834	8,367	21,909	4,701	11,943	-88	76,222	25,970	10,582	9,213	1,813	6,136	37,540	1,015,364
May 1987	516,955	273,953	7,006	20,803	4,211	16,079	1,162	76,040	25,276	11,424	8,881	1,987	5,901	36,913	1,006,601
Jun 1987	525,290	274,395	7,993	22,036	5,157	4,883	-997	75,831	26,067	13,362	12,588	2,317	7,648	37,491	1,014,153
Jul 1987	528,433	275,264	8,362	21,358	1,741	6,296	7681	75,664	25,412	13,201	12,473	1,646	7,023	37,254	1,021,810
Aug 1987	518,564	274,571	7,371	23,422	4,364	4,700	2,100	76,403	25,563	10,473	16,160	2,338	5,927	37,045	1,009,001
Sep 1987	515,456	270,192	8,133	21,306	4,676	3,949	-2,500	74,013	24,810	10,132	13,918	2,785	6,236	36,481	986,566

Table B-3. Monthly other MPN obligations

	Cadets/ midshipmen	Enlisted				Total MPN	Reimbursables
		BAS	SIK	PCS	Other		
Oct 1982	2,893	33,942	21,762	61,845	292	1,211,228	7,367
Nov 1982	2,805	33,578	20,961	43,157	317	1,165,213	6,946
Dec 1982	2,873	34,883	21,066	46,561	301	1,167,298	7,089
Jan 1983	3,641	34,985	19,036	29,989	403	1,168,832	8,558
Feb 1983	2,802	31,521	20,547	34,482	311	1,154,022	7,493
Mar 1983	2,890	34,839	18,410	36,756	336	1,175,232	8,678
Apr 1983	2,794	34,144	22,574	39,390	475	1,186,096	8,398
May 1983	2,513	33,839	23,110	37,086	382	1,192,993	7,136
Jun 1983	2,135	33,675	19,401	57,700	248	1,205,723	10,305
Jul 1983	2,877	34,857	18,552	39,658	441	1,231,608	8,094
Aug 1983	2,824	34,839	17,226	51,261	255	1,200,287	7,057
Sep 1983	2,939	35,289	22,378	39,776	254	1,228,167	7,712
Oct 1983	2,882	34,948	21,389	73,378	401	1,244,120	7,775
Nov 1983	3,422	34,645	20,806	39,161	297	1,202,405	7,413
Dec 1983	2,875	35,175	21,819	42,055	324	1,206,917	7,467
Jan 1984	2,853	36,700	17,780	43,671	264	1,255,925	6,786
Feb 1984	2,780	34,365	20,693	29,881	10,081	1,242,224	8,130
Mar 1984	2,799	35,866	21,710	33,535	273	1,234,603	10,326
Apr 1984	2,777	35,798	19,613	42,560	312	1,250,691	8,343
May 1984	2,630	35,707	23,153	49,864	10,145	1,300,327	7,931
Jun 1984	2,102	36,666	25,612	53,985	286	1,295,814	8,759
Jul 1984	2,806	37,504	13,972	49,059	301	1,299,058	9,282
Aug 1984	2,923	36,929	24,421	32,265	19,921	1,308,548	8,383
Sep 1984	2,887	43,538	26,285	28,689	276	1,244,100	8,508
Oct 1984	2,889	37,376	22,264	69,697	9,004	1,344,564	7,609
Nov 1984	3,409	36,837	21,668	38,678	294	1,264,231	8,527
Dec 1984	2,848	37,597	24,386	47,556	9,620	1,294,430	9,336
Jan 1985	2,833	39,017	23,749	32,813	318	1,339,275	7,749
Feb 1985	2,787	36,228	19,186	38,370	309	1,328,138	10,799
Mar 1985	2,805	39,834	15,655	38,606	9,532	1,342,621	13,071
Apr 1985	2,785	37,216	19,209	37,948	240	1,355,102	5,162
May 1985	2,615	39,733	20,208	49,582	1,679	1,344,954	7,923
Jun 1985	2,090	37,795	22,388	59,480	9,625	1,382,984	9,075
Jul 1985	2,902	39,542	20,283	49,741	281	1,388,531	9,268
Aug 1985	2,959	39,716	22,614	43,764	290	1,356,104	11,703
Sep 1985	2,897	38,404	21,885	41,982	9,601	1,371,417	15,340
Oct 1985	2,904	40,007	21,116	56,913	8,260	1,420,500	9,876
Nov 1985	2,879	40,646	18,513	36,705	244	1,428,940	9,753
Dec 1985	3,746	40,862	18,513	38,447	6,280	1,398,522	9,563
Jan 1986	2,873	41,180	22,014	39,578	341	1,402,459	9,411
Feb 1986	2,828	36,931	13,778	51,780	261	1,404,627	8,693
Mar 1986	2,848	41,130	16,399	33,828	8,111	1,395,781	11,728
Apr 1986	2,833	38,419	21,994	44,734	253	1,423,119	8,440

Table B-3. (Continued)

	Cadets/ midshipmen	Enlisted				Total MPN	Reimbursables
		BAS	SIK	PCS	Other		
May 1986	2,640	40,401	24,623	55,361	272	1,423,521	9,196
Jun 1986	2,147	35,638	18,840	62,480	7,513	1,416,500	9,220
Jul 1986	2,802	40,439	20,828	56,364	311	1,456,577	12,957
Aug 1986	2,963	49,106	20,327	51,896	313	1,379,152	6,655
Sep 1986	3,046	46,755	22,863	38,269	6,101	1,386,567	14,049
Oct 1986	2,944	42,717	20,198	49,607	8,911	1,500,264	8,998
Nov 1986	2,986	39,069	21,759	40,182	932	1,457,920	9,432
Dec 1986	3,823	43,787	20,847	45,156	6,604	1,468,106	8,384
Jan 1986	2,976	42,098	17,772	46,519	981	1,475,224	8,976
Feb 1987	2,841	40,633	20,962	37,236	940	1,467,086	8,686
Mar 1987	3,017	43,337	18,593	21,171	8,731	1,479,182	9,222
Apr 1987	2,965	41,868	23,685	54,531	816	1,496,032	14,250
May 1987	2,765	43,166	20,034	47,016	909	1,481,023	11,768
Jun 1987	2,286	43,067	20,108	55,097	8,167	1,506,742	7,633
Jul 1987	2,815	45,249	19,727	48,871	1,122	1,520,522	12,072
Aug 1987	3,625	44,372	22,461	30,000	1,042	1,474,113	14,489
Sep 1987	3,350	41,669	20,605	41,534	6,190	1,467,368	9,954

APPENDIX C

BAQ ENTITLEMENT DISTRIBUTIONS

APPENDIX C

BAQ ENTITLEMENT DISTRIBUTIONS

Tables C-1 and C-2 describe the percentages of personnel, on a paygrade-by-paygrade basis, that were receiving BAQ at either the "with dependents" or "without dependents" rates. The data are annual in nature and cover FY 1983 to FY 1987. The data were obtained from NMPC-7.

Table C-1. Officer BAQ entitlement distributions (percent)

	O-7+	O-6	O-5	O-4	O-3	O-2	O-1	W-4	W-3	W-2
FY 1983										
With dependents	46.8	73.3	79.0	71.8	53.4	35.7	29.1	79.0	69.2	58.7
Without dependents	1.6	3.7	6.8	11.8	27.7	39.1	48.4	3.1	1.9	1.9
FY 1984										
With dependents	48.4	72.8	79.6	70.4	52.4	37.2	26.5	77.3	71.4	69.9
Without dependents	1.6	4.9	6.7	12.8	28.0	38.4	51.6	2.7	1.8	2.1
FY 1985										
With dependents	46.0	72.0	79.8	69.0	52.4	36.9	24.1	76.3	73.8	68.0
Without dependents	3.2	4.9	6.9	13.4	28.9	39.9	52.6	3.1	2.1	2.1
FY 1986										
With dependents	43.3	71.3	79.7	68.8	52.7	35.8	24.0	75.7	88.6	70.8
Without dependents	2.4	5.0	7.3	14.2	29.3	43.9	56.4	3.2	2.3	2.1
FY 1987										
With dependents	44.1	71.7	79.9	68.3	52.6	36.3	22.2	76.9	72.1	70.4
Without dependents	1.6	4.8	7.5	14.4	29.0	47.2	56.8	2.7	2.3	2.1

Table C-2. Enlisted BAQ entitlement distributions (percent)

	E-9	E-8	E-7	E-6	E-5	E-4	E-3	E-2	E-1
FY 1983									
With dependents	79.8	72.4	65.5	59.4	43.1	29.2	21.4	15.0	9.3
Without dependents	2.1	2.8	4.0	7.2	16.1	15.1	11.1	3.9	0.6
FY 1984									
With dependents	79.5	74.0	66.9	59.3	43.9	30.6	22.1	15.4	7.2
Without dependents	2.4	2.8	4.4	7.8	16.1	14.9	10.0	3.6	0.3
FY 1985									
With dependents	80.1	74.3	67.1	59.3	44.8	32.0	24.7	11.9	6.8
Without dependents	2.5	3.1	4.6	8.5	15.7	14.2	10.5	2.9	0.3
FY 1986									
With dependents	81.4	75.7	67.4	59.9	45.8	32.2	23.4	14.6	7.4
Without dependents	2.8	3.2	5.2	9.1	15.1	13.6	10.3	2.4	0.2
FY 1987									
With dependents	82.1	76.4	68.2	60.2	46.8	32.6	24.2	15.5	7.8
Without dependents	3.2	3.5	5.4	9.1	14.4	13.5	9.9	1.9	0.2