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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Reenlistment bonuses are a powerful tool for affecting the retention behavior of enlisted personnel. The proper allocation of these bonuses across ratings was found to require information the Navy does not currently possess. A technique was developed for assisting in this allocation process when the ideal information is not available. Recommendations are made for altering or improving the criteria on which bonus allocations are based. The Navy's personnel data system and future research needs are also evaluated.		

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THE USE OF REENLISTMENT BONUSES

CENTER FOR NAVAL ANALYSES

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Arlington, Virginia 22209

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May 9, 1975

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Encl: (1) CNA Study 1050, "The Use of Reenlistment Bonuses"
of 9 May 1975

1. CNA Study 1050, enclosure (1), examines the utility of reenlistment bonuses for enlisted personnel in the Navy. It was intended to estimate the effectiveness of reenlistment bonuses, to evaluate alternative criteria for their application, and to determine where bonuses have the highest payoff.

2. The study concludes that, while the reenlistment bonus is a powerful tool for enhancing the retention of enlisted personnel, correction of a career manning deficiency is not a particularly good criterion for its use. A measure called the "careerist premium" is developed as a criterion which takes into account the relative costs of career personnel and first-termers. It should be noted that the Navy no longer uses total career manning deficiency in applying reenlistment bonuses, but aims at manning deficiencies for personnel with more than four, but less than eleven, years of service instead.

3. Specific recommendations of the study are summarized below, with comments:

a. Recommendation. Computation of "careerist premiums" should be included in the Navy's Advancement Strength Planning System (ADSTAP) personnel management system, for the purpose of aiding the determination of bonus policy.

Comment. The Deputy Chief of Naval Operations (Manpower) does not concur because the careerist premiums do not improve the current Navy judgments as to appropriate bonuses.

b. Recommendation. The ADSTAP system's utility model is not currently suitable for use in determining the ideal enlisted force and should not be used for that purpose.

Comment. The Deputy Chief of Naval Operations (Manpower) does not concur; utility or value, in an environment where



free market conditions do not exist and, therefore, no competitive price is available, is a matter of judgment. The current ADSTAP utility model is, in fact, the only useful approximation of benefit currently available.

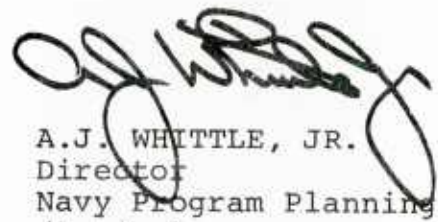
c. Recommendation. The Navy's present methods for managing undesignated personnel and computing reelistment and other retention statistics should be improved.

Comment. The Bureau of Naval Personnel has changed, and is continuing study of additional proposals to improve, its methods for managing undesignated personnel and its methods of reporting retention statistics.

d. Recommendation. There is a need for better knowledge of training costs.

Comment. The Navy believes that the several statements in the report to that effect, should not be interpreted to mean that more data must be collected. Rather, they mean that currently available data should be studied more completely and carefully to develop training costs and their determinants.

5. Enclosure (1) is forwarded.



A.J. WHITTLE, JR.
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SUMMARY

Management of the Navy's enlisted force requires, among other things, maintaining the appropriate mix of experienced and inexperienced personnel in each occupation, or "rating." With too few experienced personnel, the Navy's military capabilities are impaired. With too many experienced personnel, sufficient military capability may be achieved, but at a prohibitive cost. Since the Navy does not directly hire experienced personnel, affecting retention behavior is the principal means to alter the experience mix of the enlisted force. Retention at the first-term reenlistment point is the most critical in this context, and the reenlistment bonus is the single most flexible and powerful tool the Navy has for influencing the first-term reenlistment intentions of its enlisted personnel. This study analyzes the uses of reenlistment bonuses in the Navy.

Our analysis begins with the two choices the Navy faces when personnel reach their first-term reenlistment point. Should it accept whatever personnel losses occur at this point and replace these losses with new first-term enlistments, or should the Navy attempt to reduce these losses by offering bonuses for first-term reenlistments? The answer to this question requires three kinds of information: (1) the effect of bonuses on retention behavior, (2) the relative costs of experienced and inexperienced personnel, and (3) the relative value, to the Navy, of experienced and inexperienced personnel.

The first kind of information has proven to be the easiest to obtain. We found that reenlistment bonuses are a powerful incentive: a multiple five Selective Reenlistment Bonus (SRB) will roughly double the reenlistment rate in a rating compared to the rate without a bonus.¹ Moreover, individuals induced to reenlist by a reenlistment bonus appear to be as likely to make a career of the Navy as are individuals who would have reenlisted without a bonus.

In principal, estimating the costs of experienced and inexperienced personnel should also be relatively easy. Only the cost of training, one major cost of inexperienced personnel, is an exception to this statement. Indeed, another study effort, at least the equal to this one, is necessary to fully understand the determinants and extent of training costs. We have here been forced to use what we believe are very crude measures of training costs. Unfortunately, our estimates of other costs of experienced and inexperienced personnel are also not as good as they might be.

We used two measures of the relative value, or productivity, of experienced and inexperienced personnel. One was developed as part of this study, while the second was developed for use in the Navy's enlisted force management system, ADSTAP. Neither productivity estimate is satisfactory for our purposes, and both are subject to considerable error.

The lack of a satisfactory measure of the productivity of enlisted personnel prohibits giving definitive answers to the question of which ratings should receive reenlistment bonuses. We present below a technique estimating what we have termed careerist premiums, which can provide guidance in answering this question, *without* requiring information about enlisted productivity. Our analysis also has implications for other aspects of bonus policy, as well as future research issues.

¹An explanation of this calculation and the SRB can be found in the text below. See especially footnote 1, page 7.

The following are the major conclusions and recommendations of our work:

(1) The Zone A SRB bonus (payable to first-term reenlistees) should not be viewed solely as a means to correct career manning deficiencies. It is likely to be a slow and expensive tool for doing so.

(2) Estimating careerist premiums, for the purpose of facilitating the process of bonus determination, should be considered for inclusion in the ADSTAP system.

(3) The Zone B SRB bonus (payable to second-term reenlistees) should not be used, with two exceptions: (a) as a method of encouraging lateral conversions, and (b) as a possible substitute for the nuclear petty officer continuation pay.

(4) Several improvements in the current enlisted personnel data system should be considered: (a) almost exclusive use of Active Duty Base Date data rather than Pay Entry Base Date data; (b) stop counting six-year enlistees as reenlistments at the four-year point; (c) more complete and accurate reporting of the length of extensions and reenlistments.

(5) Improved control and reporting of the assignments of non-rated personnel should be seriously considered.

(6) The ADSTAP productivity profile (or any other estimate of enlisted productivity) does not currently seem suitable for use in optimization models for enlisted force management.

(7) We have highlighted two areas which have a critical need for further research: (a) enlisted productivity; (b) the costs of training, both in formal schools and on the job.

INTRODUCTION

In any large organization the cost of labor takes on great significance simply because of its magnitude. The United States Navy is no exception. In FY 1974 the cost of paying and maintaining only military personnel was about \$5 billion. Obviously, then, even very small improvements in the efficiency with which personnel are paid or used can yield very substantial dollar savings.

Altering retention behavior of enlisted personnel is one of the most important methods of affecting personnel costs in the Navy, and reenlistment bonuses represent the single most powerful and flexible tool for doing so. This study examines the use of reenlistment bonuses in the Navy. In particular, we estimate the effects of reenlistment bonuses on current and future retention behavior and ask both to whom the bonuses should be paid and how large they should be.

The largest amount of personnel turnover occurs at the end of the first-term enlistment. At this point the Navy has two choices: (1) simply replace losses at the end of the first enlistment with *new* first-term enlistments or (2) attempt to induce higher retention by paying bonuses for first-term reenlistments. This choice can be viewed as simply a question of the optimal mix of first-termers and careerists (the latter being those with, roughly, more than four years service). Careerists are more expensive than first-termers because personnel costs in the Navy are directly related to the experience or length of service (LOS) of individual personnel. Individuals with greater LOS draw higher pay and are generally more expensive to maintain since they make more intensive use of fringe benefits such as medical care and PX and commissary privileges and are more likely to draw retirement benefits. While more expensive than first-termers, careerists are presumably more productive as well. First-termers, on the other hand, are both cheaper and less productive than careerists and require some investment in initial training before they can be productively employed.

In the light of this discussion, we have chosen to view the question facing the Navy as follows. Given the relative costs and productivity of first-termers and careerists in a rating (occupation), which investment is likely to be more productive: an investment in more careerists in the form of reenlistment bonuses, or an investment in first-termers in the form of initial procurement and training costs?¹

In what follows we first present a theoretical framework for addressing the preceding question and a discussion of the issues and problems involved in applying this theory. We then discuss possible applications of our methodology, followed by our conclusions and recommendations. The appendixes present details of our estimation techniques and summarizes complementary research efforts of the authors, some of which are published elsewhere.

¹We have ignored, throughout this study, the possibility that the prospect of a first-term reenlistment bonus serves as an inducement to *enlist* (and thus reenlistment bonuses may lower procurement costs). In this sense (as well as in others we discuss below) our analysis is only a partial treatment of the larger questions of what is the optimal experience mix and what is the most efficient pay package associated with this mix.

THEORY

The theory outlined below is by no means original with us. Its form and implications have been part of the economic literature for at least 75 years, and it was applied in the military context in 1964 by Gorman Smith (reference 1). Nevertheless, it has never been consistently applied to military personnel problems. This is no more true of the Navy than of the other services. (Some notion of Smith's work, however, appears to lie behind OSD's criteria for application of special pays.)

We begin with the assumption that the Navy wishes to maximize its output (presumably military effectiveness) within a budget constraint and, perhaps, a manpower constraint. In the absence of any training or reenlistment bonuses (both of which can be viewed as investment expenditures by the Navy), the optimal allocation of funds within a rating requires that

$$\frac{MP_i}{E_i} = \frac{MP_j}{E_j} \quad (1)$$

for all $i \neq j$, where MP_i refers to the marginal product of individuals in the i th class (LOS cell, for example) and E_i refers to the marginal expenditure by the Navy necessary to "buy" the services of that individual.

By marginal product (MP_i), we mean that addition to or subtraction from *total* military effectiveness supplied by the rating under consideration which results from the addition or subtraction of *one* individual in the i th class from that rating, all other things remaining the same. Similarly, E_i refers to the change in total expenditures on that rating resulting from the addition or subtraction of one individual from the i th class, all other things remaining the same. Further, both MP_i and E_i have a time dimension: both are in, say, units per month or per year. For example, MP_i should be interpreted as "marginal product per year."

That satisfying the equality in (1) leads to an optimal allocation of funds within the rating can be seen from the following example. Note that the ratio $\frac{MP_i}{E_i}$ reduces to simply the "marginal product per dollar" of individuals in the i th class. Then we can set $E_i = E_j = \$1/\text{year}$. If

$$\frac{MP_i}{E_i} > \frac{MP_j}{E_j} \quad (2)$$

then equality (1) is not satisfied and we know $MP_i > MP_j$ (since $E_i = E_j = \$1/\text{year}$). If we "buy" one dollar more of the services from individuals in the i th class and one dollar less from individuals in the j th class, we spend no more on this rating, while gaining MP_i and losing MP_j . This is a net or "free" gain in military effectiveness from this rating equal to $MP_i - MP_j$. We should continue reallocating expenditures in this fashion until the equality in (1) is satisfied. We are assured that it will eventually be satisfied by the assumption of diminishing marginal products. That is, as more individuals are added to class i , MP_i falls, and as individuals are subtracted from class j , MP_j rises.

As noted earlier, the equality in (1) represents an efficient allocation only in the absence of training or bonuses. However, the Navy provides both training and bonuses, and equation (1) must be modified accordingly. Since our interest lies in determining the efficiency of a reenlistment bonus, we can view the choices open to the Navy as two: (1) "buying" an additional "careerist" in a given rating by offering him a bonus at the first-term reenlistment point, or (2) replacing this careerist with a raw recruit who will then be trained. Both alternatives represent investments that will generate a stream of future benefits as well as a stream of future expenditures. The question is which of these investments yields the higher return to the Navy? Should the Navy invest in more careerists or should it instead invest in replacements?

As before, an optimal allocation of funds between these two alternatives requires that the following condition be satisfied:

$$\frac{\overline{MP}_C}{\overline{E}_C + B} = \frac{\overline{MP}_f}{\overline{E}_f + T} \quad (3)$$

where \overline{MP}_C = discounted expected stream of marginal products from a careerist,

\overline{MP}_f = discounted expected stream of marginal products from a first-term replacement,

\overline{E}_C = discounted expected stream of expenditures for a careerist (exclusive of the VRB),

\overline{E}_f = discounted expected stream of expenditures for a first-term replacement (exclusive of procurement and training costs),

B = the cost of "buying" an additional careerist,

T = the cost of procuring and training a replacement.

The concepts of "marginal product" and "expenditure" have the same meaning as above in equation (1).

Note that B is *not* equal to the bonus actually paid for a first-term reenlistment. In particular, when a bonus is paid to elicit additional reenlistments, it is also paid to individuals who would have reenlisted without it as well as to the additional reenlistees. Thus the average cost of the additional reenlistments is greater than the average bonus paid. For example, if a \$10,000 reenlistment bonus increases reenlistments by 50 percent, two individuals who would have reenlisted regardless of the bonus receive the bonus for every additional reenlistment generated by it. Thus, the average cost of an additional reenlistment here is \$30,000, not \$10,000. The relationship between a bonus and B can be expressed as

$$\text{Bonus} (1 + 1/\sigma) = B \quad (4)$$

where σ is the fractional increase in reenlistments generated by the given bonus. In the example above, $\sigma = 0.5$.

The training cost, T, in equation (3) should be viewed as the *marginal* cost of training (and procuring) a first-termer, net of any product he produces while in training. For an individual receiving formal (Class A School) training, this is simply the cost of training as it is conventionally understood. For an individual receiving much of his training on the job, T should be net of any useful contribution to military effectiveness he produces while receiving this training.

Since equation (3) expresses the condition for an optimal allocation of expenditures, it can be rearranged to highlight the nature of the decision the Navy faces. In particular, how much should the Navy be willing to pay for an additional reenlistment (B)? Rearranging (3) gives us

$$\frac{\overline{MP}_c}{\overline{MP}_f} (\overline{E}_f + T) - \overline{E}_c = B \quad . \quad (5)$$

Here B can be interpreted as the maximum the Navy should pay for an additional reenlistment. If, for example, the Navy is contemplating paying a reenlistment bonus that implies a B equal to, say, B*, the left-hand-side of (5) must be greater than or equal to B* for this bonus to be a profitable investment. B, then, is the premium the Navy should be willing to pay for additional reenlistments.

In other words, the higher the expression on the left-hand-side of (5), the more profitable is a given reenlistment bonus to the Navy. Note that the value of this reenlistment premium rises with increases in \overline{MP}_c (the productivity of careerists) and \overline{E}_f and T (the costs of maintaining, and procuring and training, a replacement). It falls as both the productivity of first-termers, \overline{MP}_f , and the costs of maintaining a careerist, \overline{E}_c , rise. Similarly, as B, the cost of inducing an additional reenlistment, rises, the "profitability" of a given bonus falls.

It is important to note here that neither the preceding discussion nor our final result, equation (5), make any mention of "requirements." Currently the Navy's principal criterion for application of a bonus is some measure of the career manning deficiency—a shortage of careerists relative to the number of billets that should be filled by careerists (careerist requirements). The thrust of the analysis in this section is that this criterion is essentially irrelevant. Implicitly, a shortage of careerists should be reflected in the relative values of careerists and first-termers, the term $\frac{\overline{MP}_c}{\overline{MP}_f}$ in equation (5). But considering *only* requirements or a career manning shortage ignores another equally important criterion, the relative costs of careerists and first-termers (the terms \overline{E}_c , \overline{E}_f , and T in equation (5)).

This, then, is the theory underlying our work. As will be obvious below, implementing it is much more difficult than outlining it. Before turning to a discussion of the necessary empirical work, note that this theory has a wide range of possible applications. A similar approach was used at CNA to study physician procurement strategies in the absence of a draft (reference 2), and the theory is appropriately applied wherever the Navy is faced with investment alternatives in the manpower area. Thus, it can and should be applied to the decision-making process concerning any reenlistment bonuses, such as those authorized by the Selective Reenlistment Bonus (SRB) legislation. It is also applicable to related questions on the timing of training, and the use of separation pays.

*where
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ESTIMATION

We have estimated equation (5) for seven Navy ratings.¹ This section describes this estimation process and the issues it raises. Details of the actual data used and its sources can be found in appendix A.

DATA

Estimation of equation (5) requires estimates of the six separate terms it contains: \overline{MP}_c , \overline{MP}_f , \overline{E}_c , \overline{E}_f , T, and B. The first four terms are themselves composites, requiring several separate and unrelated pieces of information. Consider, for example, the term \overline{MP}_c , defined as the discounted expected stream of marginal products from a careerist. It can be expressed as

$$\overline{MP}_c = \sum_{i=5}^{20} c_i^5 (1+r)^{5-i} MP_i \quad (6)$$

where i refers to years of service, MP_i is defined as before, c_i^5 is a "cumulative continuation rate"—the probability that an individual beginning year 5 in the Navy will still be in the Navy at the beginning of year i —and the term $(1+r)^{5-i}$ is the discount factor where r is the appropriate discount rate.² The c_i and MP_i should, of course, be allowed to vary across ratings. Similarly, \overline{MP}_f , \overline{E}_c and \overline{E}_f can be expressed as

$$\overline{MP}_f = \sum_{i=1}^{20} c_i^1 (1+r)^{1-i} MP_i \quad (7)$$

$$\overline{E}_c = \sum_{i=5}^{20} c_i^5 (1+r)^{5-i} E_i \quad , \text{ and} \quad (8)$$

$$\overline{E}_f = \sum_{i=1}^{20} c_i^1 (1+r)^{1-i} E_i \quad , \quad (9)$$

where E_i is defined as before. Thus the estimation of equation (5) requires the following specific information for each rating:

- Continuation behavior (to estimate c_i)
- The effect of reenlistment bonuses on first-term reenlistments and the subsequent continuation behavior (to estimate B and c_i)

¹The seven ratings are Air Controlman (AC), Aviation Electrician's Mate (AT), Aviation Ordnanceman (AO), Boiler Technician (BT), Engineman (EN), Hull Technician (HT), and Operations Specialist (OS). Five of these ratings (AE, AO, BT, HT, and OS) have been designated "sick" by their respective rating coordinators. All first-term reenlistees in these seven ratings received a Variable Reenlistment Bonus (VRB) during FY 1974. AOs received VRB at multiple 1, AEs at multiple 2, and the other five were all at VRB multiple 4 during FY 1974.

²Note that the summation in equation (6) ends with year 20. Throughout this paper we have made the simplifying assumption that an enlisted career ends at 20 years of service.

- The productivity profile of individuals through a 20-year career (estimates of MP_i)
- The costs of maintaining personnel through a 20-year career (estimates of E_i)
- The cost of procuring and training a replacement (estimates of T)
- The appropriate discount rate (r).

Continuation Behavior

Knowledge of continuation behavior is necessary to estimate the expected costs and benefits of personnel through a 20-year career (the c_i in equations (6)-(9)). We have used continuation rates which were prepared by the Bureau of Naval Personnel (BuPers) for use in the Billet Cost Model of the ADSTAP enlisted force personnel management system.¹ These rates, while subject to some errors, are probably the best presently available. Where these rates are known to have the greatest errors—in the first five or six LOS cells—we have made some adjustments designed to at least partially offset these errors. These adjustments are described in appendix A. Two of the principal defects in this continuation data are worth noting here. First, these continuation rates are based on experience in the early 1960s. It is not obvious that this experience is relevant for predicting behavior in the 1970s. Second, the data is potentially flawed by the possibility of lateral entries to ratings and the use of pay entry base date rather than active duty base date to classify people by length of service. These problems generate errors of unknown size and direction in the continuation rates we have used. A discussion of these and other defects of continuation data, as well as other problems associated with the Navy's retention data, can be found in appendix B.

The Effect of Reenlistment Bonuses

As noted earlier, the B in equation (5) is larger than the actual bonus paid for a reenlistment because of the necessity of paying bonuses to those who would have reenlisted without a bonus as well as to those induced to reenlist by the bonus. How much larger depends on the responsiveness of reenlistments to the payment of a bonus. Fortunately, a great deal of effort has been devoted to answering this question at CNA and elsewhere. For our purposes here we have used a pay elasticity of 3.0. This is roughly the mid-point of the estimates made as part of this study (see appendix C) and is consistent with previous work as well.² This implies that a bonus of VRB multiple 4 (or SRB multiple 5) would increase a reenlistment rate about 100 percent—from, for example, 10

¹The ADSTAP system is a complex of computer models and data banks used by BuPers for the purposes of personnel management. An overview of the system can be found in Bureau of Naval Personnel, "U.S. Navy Enlisted Force Management and the ADSTAP Master System: Second Interim Report," 30 Jun 1973 (reference 3). We have used other data compiled for the ADSTAP system in addition to the continuation rate data, and will have occasion to discuss various aspects of ADSTAP below.

²See, for example, the papers by Nelson, Wilburn, and Grubert and Weiher in reference 4. Pay elasticities estimated in these papers ranged from a low of 2.2 to a high of 4.9. Estimated impact of VRB on reenlistment rates contained in table I of DoD Instruction 1304.13, August 15, 1968, are consistent with an elasticity of between 2.0 and 3.0. Kleinman and Shughart (appendix C) estimated pay elasticities ranging between 2.2 and 4.2.

percent to about 20 percent.¹ In practice, of course, more reliable estimates of B for any given rating ought to be obtained by experimentation, since all previous studies have estimated an average across all ratings.

The use of reenlistment bonuses raises another question concerning their effect. Since a reenlistment bonus is designed to induce reenlistments by individuals who would not otherwise reenlist, it is possible that the career commitment of these individuals might be less than that of individuals reenlisting without the bonus. This is important for the issues we address here—if a reenlistment bonus only “buys” a second term of enlistment rather than a “career,” the marginal reenlistment induced by the bonus will not cost the Navy the same (nor “benefit” the Navy the same) amount an average careerist does. In terms of equation (5), since \bar{E}_C and $\bar{M}P_C$ are *expected* values, it is necessary to know the expected continuation behavior of a reenlistee and whether this varies with either the size or existence of a reenlistment bonus. Because of the relatively short time the Navy has used the VRB (roughly eight years), there is not a great deal of information to draw on to illuminate this issue. Results of research summarized in appendix C suggest, however, that subsequent continuation behavior is unaffected by reenlistment bonuses. Consequently, we assume here that the bonus-induced reenlistee is as likely to serve a full 20-year career as is his counterpart who would have reenlisted without a bonus.

The results and assumptions described in the preceding two paragraphs are, strictly speaking, relevant only for four-year enlistees. The research summarized in appendix C did not consider the effects of bonuses on the behavior of six-year enlistees. This is a result of the method the Navy used for treating the reenlistment statistics of six-year obligors (6YOs). Virtually all six-year enlistments are composed of a four-year contract and a required two-year extension at the four-year point. Until FY 1973 the Navy counted these automatic two-year extensions as first-term reenlistments and then also counted the first reenlistment beyond the six-year point as a first-term reenlistment. Consequently, first-term reenlistments in ratings with 6YOs were biased upward and research into the behavior of 6YOs is severely hampered.² The problem is further compounded by the fact that few ratings are populated solely by 6YOs. Two possible techniques for correcting these problems are described in appendix B.

¹The calculations in the text were made consistent with the data used for the research summarized in appendix C. If R_0 is the first-term reenlistment rate (FTRR) without a bonus and R_1 is the FTRR with a bonus, the effects of a bonus can be calculated using the constant elasticity formula:

$$\frac{R_1}{R_0} = \left(\frac{\text{Pay} + \text{Bonus}}{\text{Pay}} \right)^{\text{elasticity}}$$

The pay figures used were based on regular military compensation (RMC) as of July 1, 1973. A multiple 5 SRB was assumed to equal \$10,000.

Prior to the implementation of the new SRB legislation at the end of FY 1974, all first-term reenlistees received a regular reenlistment bonus (RRB). The RRB was calculated as the reenlistee's monthly base pay at the time of reenlistment times the number of years for which he reenlisted (but at least two years). Thus an individual reenlisting for four years would receive an RRB equal to four times his monthly base pay. In ratings assigned a variable reenlistment bonus (VRB) reenlistees also received a bonus (the VRB) equal to the RRB times the VRB “multiple.” VRB multiples were integers ranging between 1 and 4. Thus an individual reenlisting for four years in a rating assigned VRB multiple 4 would receive a total bonus equal to his monthly base pay times four (years) times five (VRB multiple 4 plus 1 for the RRB). The new SRB legislation eliminated the RRB and specified calculation of the SRB in the same fashion as the VRB was calculated. For example, a four-year reenlistment in a rating assigned SRB multiple 5 would merit a bonus equal to monthly base pay times four (years) times five (SRB multiple 5). Thus a multiple 4 VRB equals a multiple 5 SRB.

²Although this method has been changed, the problem has not been eliminated. Currently, 6YOs are counted as first-term reenlistments at the four-year point, and as career reenlistments beyond that point.

Productivity of Enlisted Personnel

We considered two different measures of productivity for the purpose of estimating the terms MP_C and MP_F in equation (5). One was developed for use in the ADSTAP system and the other was developed as part of this study and is described in appendix B. Both are subject to some serious deficiencies.

Although in practice it may be difficult to separately identify them, there are two sets of factors influencing an individual's productivity on the job. The first set include personal characteristics, such as innate intelligence or aptitude; age; suitability to the Navy (and to the job); and motivation; as well as acquired characteristics such as training, experience, and formal education. The second set of factors would describe the environment in which the individual is working and includes such things as the quantity and quality of both his co-workers (the labor mix) and the tools or equipment with which he is working (the capital-labor ratio).

Although the direction of the effect any one of these factors has on productivity can usually be determined *a priori*, the *quantitative* effects are unknown. For example, while increasing experience probably leads to increases in productivity (at least initially), how much of an increase is unknown. Further, the extent to which increasing experience, training, or intelligence increases productivity probably differs across jobs or ratings.

The same can be said for the effects on productivity of the labor mix and the capital-labor ratio. In terms of our earlier discussion, economic theory predicts that increasing the percentage of careerists in a rating, other things equal, will increase the productivity of an extra or marginal first-terminer and decrease the marginal product of careerists. Unfortunately for our purposes, the size of these effects, which probably differs across ratings, is an empirical question. Similarly, theory suggests an increase in the capital-labor ratio will increase labor productivity, but again, how much, can only be answered empirically.

Unfortunately, both the ADSTAP and CNA measures confound all these factors. Table 1 presents a comparison of these two measures for four of the seven ratings we are studying. (Because of data limitations, the CNA estimates could only be completed for four ratings.) Relative to the CNA measure, the ADSTAP measure understates the value of personnel in the first two or three years of service. The CNA profile is somewhat more credible for this reason, but this statement is based on our subjective judgment rather than known facts. Neither the ADSTAP nor the CNA profile, in their present form, is particularly reliable.

Consider first the ADSTAP profile. It is ultimately based on subjective questionnaire responses which can raise some doubts immediately. More importantly, serious objections can be made to the final result. For example, the nature of the questionnaire process used and the final productivity profile itself did not provide for any differences in relative productivity across ratings.¹ Thus the ADSTAP profile does not account for differences in either the labor mix or the capital-labor ratio. It also does not reflect differences in the intensity of formal training across ratings. The function of training, after all, is to increase the productivity of the individuals trained. These differences in training are potentially a source of difference in the productivity profile across ratings.

¹The slight variation across ratings in table 1 for the ADSTAP profile is a result of different times for advancement across ratings. The underlying data for table 1 is a paygrade versus LOS matrix of productivity or "utility" values which does *not* vary across ratings. (This table is reproduced as table A-2 in appendix A.)

TABLE 1
COMPARISON OF ADSTAP AND CNA PRODUCTIVITY
PROFILES FOR ENLISTED PERSONNEL IN
SELECTED RATINGS, BY YEARS OF SERVICE
(Index, 100 = highest productivity)

Year	AC		AE		BT		EN	
	ADSTAP	CNA	ADSTAP	CNA	ADSTAP	CNA	ADSTAP	CNA
1	4.8	24.5	4.8	28.8	4.8	29.8	4.8	26.8
2	18.8	27.7	18.8	31.9	18.8	32.3	18.8	29.2
3	43.6	32.3	33.8	36.6	32.6	35.6	32.6	32.7
4	48.0	41.4	44.4	42.5	43.2	40.3	42.0	34.7
5	54.0	44.3	54.0	49.8	54.0	51.6	46.8	37.0
10	65.0	58.5	65.0	65.5	65.0	63.4	65.0	53.5
15	78.0	70.8	78.0	75.5	78.8	75.8	78.0	66.3
20	94.0	84.8	94.0	94.9	96.8	96.4	96.8	95.8
25	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
30	91.0	100.0	91.0	100.0	91.0	100.0	91.0	100.0

Source: See appendix A.

Perhaps more importantly, however, the ADSTAP profile simply strains credulity. It shows, for example, that an E-5 with 25 years experience is only half as valuable as an E-7 with the same experience and less than half as valuable as an E-9. (See table A-2.) A logical implication of this is that speeding up promotions in a rating will increase the productivity of individuals in that rating. Also, the figures in table 1 show that a man in his 20th year of service is "worth," to the Navy, somewhat more than five times as much as a man in his second year of service. It is difficult to picture the commanding officer of a ship being willing to exchange *five* two-year men for *one* 20-year man, yet that is what the ADSTAP profile suggests he ought to be willing to do.

The CNA profile is based on firmer conceptual grounds than the ADSTAP profile but it, too, is seriously flawed. It is important to recognize that we view the research reported in appendix D as very preliminary—a demonstration of a possible methodology rather than a definitive answer. Another separate study would be necessary to do justice to the methodology outlined in appendix D. This methodology is based on the premise that there is much to be learned about the productivity of individuals in the Navy from the productivity of similar individuals in the civilian sector. This premise is both a vice and a virtue of the work reported in appendix D. It is a virtue because the resulting productivity estimates are based on objective facts rather than subjective judgments. It is a vice because we have assumed that those factors which affect civilian earnings (and, by implication, civilian productivity) will have the same effect on Navy productivity. Further, even in the context of a demonstration, there are several possible improvements to the work reported here.

Productivity has been estimated as a linear function of the age, educational attainment, and marital status of individuals in a rating. This linear functional form is objectionable on the grounds that there is evidence that civilian earnings are not a *linear* function of age and that the relationship between age and earnings may itself be a function of educational attainment. In short, the form of equation (D-3) in appendix D is probably incorrect.

It is also questionable whether education and marital status have the same effect on Navy productivity as they do on productivity in the civilian sector. For example, if the high school

graduates that the Navy attracts and retains have lower (or greater) aptitude than the average high school graduate in the civilian sector, then the productivity of the Navy's high school graduates will be lower (or greater) than that estimated in appendix D.

The CNA productivity estimates are based on the presumption that earnings in the civilian sector reflect productivity. But this is true only when earnings have been adjusted for intensity of effort or hours of work. Unfortunately, the earnings figures used in appendix D represent total earnings rather than some conceptually more appropriate measure such as hourly wages or full-time earnings. If marital status affects total civilian earnings only because married men tend to work more (rather than "better"), in the form of longer hours or second jobs, then our adjustment for marital status in the Navy case is inappropriate. If so, this would bias downward the CNA estimate of the value of inexperienced (mostly unmarried) personnel relative to experienced (mostly married) personnel.

Like the ADSTAP productivity profile, the estimated CNA profile does not reflect differences in training across ratings. At least equally important, the CNA profile does not reflect differences in training between the civilian sector and the Navy. In particular, the Navy generally provides more training to new accessions than do most firms in the civilian sector. Thus the CNA estimates of the productivity of junior enlisted personnel are probably biased downwards for this reason as well.

Since CNA productivity profiles were estimated on the basis of civilian earnings, these estimates are a function of the mix of inexperienced and experienced personnel in the civilian sector (among other things). There are relatively more experienced personnel in the civilian sector than in the Navy, so for this reason the CNA productivity estimates would bias upward the estimate of the relative value of inexperienced personnel in the Navy (or bias downward the estimated value of experienced personnel).

An additional possibly important determinant of the earnings in the civilian sector, job tenure, was not considered in making the CNA estimates. Job tenure appears to have a positive effect on earnings in the civilian sector. Since a 20-year man in the Navy has more job tenure than the typical person with 20 years experience in the civilian sector, a 20-year Navy man ought to be relatively more productive than his civilian counterpart. However, 20 years experience in the Navy does not always imply 20 years of work at the same sort of job, so the size, and even direction, of this job-tenure effect is not so obvious.

In short, neither the ADSTAP nor CNA productivity profiles are particularly useful or reliable for our purposes here. (This is also true of other productivity estimates, many of which are referenced in appendix D.) The estimates of marginal product represent the weakest link in our estimation of equation (5). This will be even more obvious when our actual estimates are presented below.

Maintenance Costs of Enlisted Personnel

We have defined maintenance costs as those costs incurred by the Navy to maintain an enlisted man, exclusive of first-term training and procurement costs, and any variable reenlistment bonus (VRB or SRB) at the first reenlistment point. Maintenance costs thus include base pay, BAQ, BAS, any special pays (sea pay, hazard pay), training costs other than those incurred in the first-term, retirement costs, in-kind benefits such as health care, and other benefits. For the purposes of this discussion, we will divide these costs into two categories: retirement costs and all other wages and benefits. In principle, the latter category presents no difficult estimation problems, merely the tedious chore of collecting the appropriate figures.

Estimating retirement costs is not so easy, due to the fact that retirement "contributions" are not vested until the 20th year of service has been completed. A separate and sizeable paper is necessary to do justice to the issues raised by retirement costs, so only the most important of these issues will be mentioned here.

Given knowledge of continuation behavior and hence the percentage of any year-group expected to reach retirement, the size of the annuity at the 20-year point necessary to pay future retirement benefits can easily be calculated from knowledge of the benefit stream and survival rates of retirees. What is not so easy to determine is the appropriate methodology for allocating the cost of this annuity across the years of active duty. Three major questions appear immediately.¹

First, what interest rate should be used? Since early "contributions" to the retirement fund will earn interest to the 20-year point, the sum of the contributions need be less than the size of the annuity. How much less, however, depends on the interest rate.

Second, how should the so-called "unfunded liability" be handled? Since retirement benefits are specified as a percent of base pay, increases in base pay increase the necessary size of the required annuity at the 20-year point. Yet any contributions prior to a pay raise do not take account of these subsequent pay raises. Current DoD accounting practices do not adequately address this issue either.

In principle, these two issues are related. If, for example, pay raises were merely the result of increases in the cost of living, using an interest rate lower than the nominal rate assigned as the return on the (fictitious) retirement trust fund could account for the unfunded liability. Thus if the appropriate nominal rate of return on the "trust fund" were 7 percent and the rate of inflation (and hence by assumption the rate of increase in base pay) were 4 percent, using an interest rate of 3 percent (7 percent minus 4 percent) would adequately allow for the unfunded liability. Of course pay raises are affected by the rate of inflation, but they are influenced by other factors as well. Since pay raises are made on the basis of changes in civilian compensation, military pay will still rise at roughly the same rate as civilian labor productivity rises when the rate of inflation is zero.² Nevertheless, choosing an appropriate interest rate could correct for this effect as well. The division of increases in military pay between base pay (on which retirement benefits are based) and allowances for subsistence and quarters cannot, however, be adequately treated by adjustments in the interest rate unless this division is predictable over time.

Third, how shall the necessary contributions to the fund be allocated across a 20-year career, once questions concerning interest rates and the unfunded liability have been appropriately answered? Should the contributions be the same size or the same percent of base pay for each year of service? Since the Navy (and all the services) reserves the right to prevent many individuals from reaching retirement by screening at the first-term reenlistment point, should retirement costs be attributed to first-termers in the same fashion as they are to careerists? Current DoD costing techniques specify a fixed percentage of base pay during all years of service as the retirement contribution, yet the validity of this approach is open to question. In this study, for example, we have argued that the Navy faces the choice, at the margin, between "buying" additional careerists or replacing losses with new first-termers, only a few of whom will ever draw retirement benefits. It might be more appropriate,

¹We ignore here the possibility of disability retirement. While disability retirements at or beyond the 20th year of service do not increase the *budget* costs of retirements, they do increase the *net* government cost of the pensions since disability pensions are taxed at lower rates than normal pensions.

²This assumes the so-called comparability calculations are made in an appropriate fashion.

then, to charge the full present value of the retirement annuity to each additional reenlistment induced by a bonus. In short, the appropriate technique for allocating retirement costs probably ought to differ with the use to which the results will be put.

In the calculations presented below, retirement costs are allocated in the following way. We allocate the full present value of the retirement annuity to the careerist (for the reasons outlined above) and first-term retirement costs are based on the probability of a first-termer drawing retirement benefits in the absence of any reenlistment bonuses. (See appendix A for details.) We have based these calculations on FY 1974 base pay and have made no allowance for either inflation or the escalation of base pay.

For maintenance costs, other than retirement, we have relied exclusively on costs calculated for use in the ADSTAP system.¹ These costs, however, include procurement and initial training costs. We have chosen to treat these costs somewhat differently than ADSTAP does and consequently have adjusted first-year costs to include only those costs incurred after initial training is completed. (Our estimation of procurement and training costs is discussed in the next section.)

Training Costs

As noted earlier, one very important consideration in the decision to pay reenlistment bonuses (and how large they should be) is the cost of procuring and training replacements. Other things equal, the higher are training costs, the more "profitable" any given bonus will be. This fact is, indeed, explicitly recognized by OSD in that one of the most important criteria for granting the use of reenlistment bonuses is the cost of training. Unfortunately, the Navy (and the other services) know very little about the costs of training, particularly training beyond boot camp.

The Navy regularly collects data and calculates average training costs for all occupational specialties (see reference 7). What is needed, however, is not average cost but marginal cost. We need to know, for example, not what it costs *today* (or yesterday) to train ETs, but what it *would* cost to train more or less ETs than we currently train. If we train 10 percent more, will total training costs go up 10 percent, or more or less than 10 percent? The use of average costs implies the assumption that a change in the training load will lead to a proportional change in costs. There is no reason to expect this to be generally true.

Answering these questions requires rather detailed knowledge of the factors influencing training costs, such as student load, peak loads, and staff-student ratios. This is knowledge the services do not currently possess.

Further, it is not even clear how accurate the averages are that the Navy calculates. The Naval Training Command performs a variety of tasks, some of which are only superficially related to the actual training function. To what extent are the costs of these other functions counted as training costs? No study effort has addressed this issue.

An effort at least equal in size to this one is necessary to fully answer these questions, so we can do no more than raise them here. Nevertheless, we have made two adjustments to the training costs calculated by the Navy. (The unadjusted costs also happen to be those used in the ADSTAP system.)

¹A rather cursory description of the ADSTAP costing techniques and data inputs can be found in reference 5. See also reference 6.

First, since the most recent calculations are based on FY 1972 data, we have inflated these calculated training costs by 10 percent to at least partially account for the certain rise in costs between FY 1972 and FY 1974. Second, we have made an adjustment to account for the fact that these average costs include fixed as well as variable costs. A preliminary study by the Naval Education and Training Command has suggested that about 75 percent of total costs vary with the training load (reference 8). That is, average *variable* costs are 75 percent of average *total* costs. Consequently, we have used 75 percent of the (inflated) average training costs as our measure of "marginal" training costs. What we are really using here is not a measure of marginal costs so much as a measure of average variable costs. If the Training Command were always operating at a level of output consistent with minimum average costs, marginal costs would be equal to (a correct measure of) average total costs. Fixed training costs, however, will reflect not only the costs of providing current training but also any excess capacity in the form of plant and equipment. Since the Navy intentionally carries such excess capacity, long-run marginal costs (the quantity we would like to have as our estimate of T) must be less than average total costs. Whether it will be 75 percent less (our assumption depends on how much excess capacity exists. In addition to excess plant and equipment capacity, there is reason to believe that the Navy is also carrying excess variable capacity in the form of instructors and other staff. If so, our assumption that marginal costs are 75 percent of average costs may well overstate marginal training costs and bias upward our estimates of B, the reenlistment premium.¹

Of course, not all training occurs in formal schools. In many ratings a significant percentage of individuals have learned all their skills on the job. Unfortunately, as little as we know about the costs of formal training (administered by the Training Command) we know even less about the costs of training on the job. For the purposes of this study we have ignored this problem. This implies an assumption that on-the-job training (O-J-T) has the same cost to the Navy as formal training. If O-J-T is *more* expensive, then the Navy should not be using it (except when constrained to do so by formal school scheduling difficulties). If O-J-T is *less* expensive than formal school, our estimates of reenlistment premiums (the B in equation (5)) should be biased upwards for those ratings where a significant fraction of personnel are trained O-J-T.

The preceding discussion has related to skill training received after basic training at the recruit training centers, but the T in equation (5) should include not only formal (and O-J-T) skill training but also procurement costs and basic training. As in the case of formal skill training, 75 percent of average costs has been used as our measure of the marginal costs of procurement and basic training. In addition, both procurement costs and basic training costs have been inflated to reflect more recent costs than do the figures used by BuPers. (Again, see appendix A for details on the actual adjustment procedures.)

Discount Rates

Two questions need to be addressed here. First, why discount future costs and returns, and second, having decided to discount, what rate should be used? The first question is much easier to answer than the second. Discounting is appropriate for two reasons. The first reason revolves around the fact that uncertainty exists. Costs and returns, especially returns, to any investment are known or can be known with much more precision for current years than for future years. For this reason current returns are more valuable than those in the future. This is more true the farther into the future these returns are. Discounting future returns reflects this idea.

¹The discussion is considerably expanded in appendix A.

A second reason for discounting is founded on the fact that any investment involves making a choice between current and future returns. That is, making an investment implies deferring current military capability for the purpose of increasing future military capability. The interest or discount rate is the price at which current and future returns (or costs) are exchanged.¹

Choosing an appropriate discount rate will account for both of these reasons, and indeed interest rates which we observe in the market reflect both factors. Market interest rates also reflect a third factor, inflation. Because of inflation, a dollar today is worth more than a dollar will be worth next year. An appropriately chosen discount rate will reflect this factor as well. Since we have made no allowance for inflation in our cost calculations, allowing for this factor in discounting here would be inappropriate.

What rate is appropriate, given these considerations? In the results presented below we have used a rate of 4 percent. That is roughly the rate which the Federal government was paying on medium to long-term bonds in the most recent non-inflationary period and is nearly the rate paid on high grade corporate securities during the same period.² This rate can be justified on the grounds that it is the rate at which government spending is financed, at the margin, and it also reflects, to some degree, the social rate of time preference.³ Nevertheless, this choice (or any other) is not completely free from possible criticism. Fortunately, this is not a particularly critical issue for our purposes. Although the actual results we present are sensitive to the choice of discount rates, the general conclusions we draw from our analysis are not. (Results using a discount rate other than 4 percent are also presented below, however.)

Perhaps as important as the choice of discount rates is the question of whether the same rate should be used to discount returns as well as costs. We have said that one reason for discounting is to reflect uncertainty. It can be argued for our case that the uncertainty attached to the value of future returns is higher than that attached to costs, and thus the rate to discount returns should be higher than that used for discounting costs. The results we present below also reflect this argument.

ESTIMATES OF THE REENLISTMENT PREMIUM

Recall equation (5) which is reproduced here:

$$\frac{\overline{MP}_c}{\overline{MP}_f} (\overline{E}_f + T) - \overline{E}_c = B \quad (5)$$

We have termed B the reenlistment premium, or the amount that the Navy should be willing to pay for an additional reenlistment. The preceding section described our methodology for estimating equation (5) and we now present the results of this estimation.

¹These issues, as well as the choice of an appropriate rate, are discussed at far greater length in reference 1, pages 147-160.

²Average rates during 1960-64 on three to five-year federal issues ranged between 3.57 and 4.06 percent. Rates on longer-term issues ranged between 3.90 and 4.15 percent during the same period while rates on Aaa corporate bonds ranged between 4.26 and 4.41 percent. See Council of Economic Advisors, *The Economic Report of the President, 1974*, (reference 9), page 317.

³That 4 percent is considerably below the current market rates is a function of the different inflationary expectations today relative to those of the early 1960s. Since we have deliberately ignored the issue of inflation it is appropriate to use this lower rate.

Table 2 presents our first set of estimates using alternative discount rate assumptions. The productivity figures underlying these estimates are based on the ADSTAP productivity profile.¹ In the column labeled "r = 4, 6 percent," costs have been discounted using a rate of 4 percent while returns (productivity) have been discounted using a rate of 6 percent to account for the possibly greater uncertainty attached to the future value of returns. As expected, the reenlistment premium generally falls as the discount rate rises. Although both costs and returns are being discounted, because returns (measured by the ADSTAP profile) rise much more rapidly with years of service than do costs, the benefits from a bonus fall as r rises.

TABLE 2
ESTIMATES OF THE REENLISTMENT PREMIUM
USING THE ADSTAP PRODUCTIVITY PROFILE

Rating	Discount rate		
	r = 4 percent	r = 4, 6 percent	r = 10 percent
AC	\$107,800	\$99,700	\$99,700
AE	80,000	73,900	79,700
AO	70,000	64,200	70,800
BT	74,800	77,600	84,000
EN	78,900	68,200	73,700
HT	112,900	98,800	79,800
OS	99,600	86,100	86,000

Source: See appendix A.

The most striking feature of the figures in table 2 is their magnitude. Recall that these are estimates of the reenlistment premium, B, and that B is related to the actual reenlistment bonus by the following expression:

$$B = \text{Bonus} \left(1 + \frac{1}{\sigma}\right),$$

where σ is the fractional increase in reenlistments induced by the bonus. A pay elasticity of 3.0 with respect to bonuses implies a σ of about 1.0 for a \$10,000 bonus.² This in turn implies a B of about \$20,000 so that the figures in table 1 suggest that a VRB 4 bonus (or SRB 5) would be more than profitable for every rating in table 2. Indeed, if the calculations were made, the same would probably be true for every rating in the Navy.

The implication, then, of this argument is clear. The Navy has too few careerists and too many first-termers—maximum bonuses should be paid in all ratings (or careerist pay raised in some other fashion) in order to increase the number of careerists in the Navy. While possibly correct, in our judgment this conclusion is not a likely one and, in any event, it is not a particularly useful one. The Navy is not currently able to implement the policy suggested by this conclusion, so analysis which suggests such a policy is not of a great deal of use.

¹We have used the ADSTAP estimates because of their availability for all ratings and their familiarity to many readers of this study. As we argued earlier, however, we have little faith in this or any other measure of enlisted productivity.

²This calculation is described in appendix E, table E-1.

A principal reason for the large numbers in table 2 is the ADSTAP productivity profile. Table 3 presents results estimated in exactly the same way as those of table 2 except that the CNA productivity profile was used rather than ADSTAP's. The sizeable differences between the corresponding numbers in tables 2 and 3 illustrate the extreme sensitivity of our results to the estimates of marginal product. Recall (from table 1) that the only significant differences between the ADSTAP and CNA productivity profiles occur in the first three years of service, yet these differences have generated the substantial discrepancy that exists between the numbers in tables 2 and 3. If both the ADSTAP and CNA profiles understate the value of first-termers relative to careerists (a very plausible case in our judgment), then the figures in both tables 2 and 3 overstate the "true" reenlistment premium.

TABLE 3
ESTIMATES OF THE REENLISTMENT PREMIUM
USING THE CNA PRODUCTIVITY PROFILE

Rating	Discount rate		
	r = 4 percent	r = 4, 6 percent	r = 10 percent
AC	\$50,000	\$41,300	\$49,800
AE	43,300	34,800	45,200
BT	11,600	5,500	23,500
EN	1,600	-3,900	15,600

Before proceeding, the results in table 3 merit further discussion. Note first the sensitivity of the results to the discounting assumption (as was also true of the figures in table 2). Although the ordering of the ratings remains the same as r varies (that is, B is always highest for ACs and lowest for ENs), the actual magnitudes differ greatly. Nevertheless, the results for the AC and EN ratings are consistent across all three columns of table 3. They show that a bonus at or near maximum (\$12,000 in FY 1975) is "profitable" for ACs, while a bonus of any size for ENs cannot be justified on the basis of the figures in table 3. Also, in all cases the figures in table 3 suggest that BTs should draw a lower bonus than AEs and both should draw a lower bonus than ACs. (This relationship also holds in table 2.) Currently (FY 1975) BTs are drawing the *highest* bonus of these four ratings, an SRB 5 bonus, AEs qualify for SRB 4, while ENs and ACs draw SRB 3.

The figures in tables 2 and 3 are roughly in line with relative training costs for the four ratings. Table 4 displays this comparison. Although not always true, in general, as training costs fall, so does the reenlistment premium.

ERRORS

Before drawing any conclusions from these results it is appropriate to discuss the direction and magnitude of any errors or bias implicit in our estimation procedure. We begin with a discussion of the errors in our various cost estimates, then conclude with some final comments on the productivity measures we have used.

As we argued earlier, we have the most faith in our estimates of the effect of reenlistment bonuses, if for no reason other than the consistency of our results with previous work. We have also used retention data (continuation rates) for years other than the first-term reenlistment point.

TABLE 4
TRAINING COSTS AND THE
REENLISTMENT PREMIUM

Rating	Training cost	Reenlistment premium (r = 4 percent)	
		ADSTAP productivity profile	CNA productivity profile
AC	\$10,800	\$107,800	\$50,000
AE	9,000	80,000	43,300
BT	5,900	74,800	11,600
EN	5,800	78,900	1,600

For careerists, this data is also reasonably accurate, if possibly outdated. These continuation rates are based on experience in the early 1960s so their relevance for current use is questionable. The size and direction of any bias introduced here is uncertain. The continuation rates we have used for first-termers are subject to some additional criticisms.

Our first-term continuation rates apply only to rated personnel; that is, individuals who have either completed formal skill training or have passed the third-class petty officer exam. We thus have not allowed for the high attrition suffered during boot camp. This has the effect of biasing downward our estimate of training and procurement costs (the T in question (5)) and thus also biasing downward estimates of the reenlistment premium.

Our treatment of training costs introduces several possible biases. First, our assumption that marginal training costs are equal to 75 percent of total average training costs is just that, an assumption. We have argued, however, that there is reason to suspect that this assumption produces estimates of marginal costs which are biased upward and hence produces an upward bias to the reenlistment premium. Similarly, ignoring the possibility of on-the-job training may also produce an upward bias in our estimates of the reenlistment premium, if O-J-T is less expensive than formal training.¹

A second bias introduced by our treatment of training costs arises because we have ignored formal training subsequent to basic and initial skill training. The costs of this training have been included in our measure of maintenance costs—at full average total cost—but any productive time lost due to this training was *not* accounted for in our estimates of the returns to either first-termers or careerists. For the ratings we have studied it appears that more training of this sort is given to first-termers than careerists. Our estimate of the costs of first-termers, relative to careerists, is thus biased upward, to the extent that average total costs for this training overestimate marginal costs. This has the effect of biasing the reenlistment premium upward. By not allowing for time lost in training we have biased upward our estimates of the returns to first-termers, which biases downward the reenlistment premium estimates. The net effect here is thus uncertain.

Our measure of maintenance costs (\bar{E}_c and \bar{E}_f in equation (5)) are taken from calculations made for the ADSTAP system. They are average costs rather than the marginal costs which are

¹This argument is amplified above on page 13.

conceptually appropriate. This is not a particularly troublesome problem, however, since the major maintenance costs are pay-related (base pay, BAQ, BAS, special pays, etc.) and for pay costs, marginals and averages are the same. What error remains has the probable effect of slightly understating the costs of careerists relative to first-termers, since careerists generally make more intensive use of other maintenance items such as PX and commissary priveleges, insurance and education programs, and the like. This in turn introduces an upward bias in the estimate of the reenlistment premium.

(One implicit maintenance cost we have not considered is the cost of post-service benefits provided by the Veteran's Administration. Some of these benefits, such as education subsidies, may be used more intensively by younger men and hence generate costs largely attributable to first-termers. Others, such as medical care, are a cost of careerists since they can only be used by retired personnel. The bias introduced by not considering these costs is thus uncertain.)

Our treatment of maintenance costs has also ignored the likelihood of future increases in military pay. This is not the issue of inflation that we have deliberately ignored. As we argued earlier, even in the absence of inflation, the comparability calculations will generate increases in military pay roughly equal to advances in civilian productivity. Thus future pay costs will almost surely be higher than they are today, even after allowing for inflationary effects. Thus the costs of careerists, relative to first-termers, is understated in our calculations and reenlistment premium estimates are biased upwards.

These various errors in estimating costs and their postulated effects are summarized in table 5. Since they operate in different directions, their net effect cannot be assessed with certainty. However, it is probable that the net effect is to upwardly bias our estimates of the reenlistment premium. The basis for this assertion is our belief that those effects which bias our estimates upward are quantitatively more important than those effects working in the opposite direction.

TABLE 5
SUMMARY OF BIASES IN ESTIMATING COSTS

Error	Probable bias in reenlistment premium
1. Outdated (?) continuation rates	Uncertain
2. First-term continuation rates	Downward
3. Estimate of marginal training costs	Upward
4. Ignore O-J-T	Upward
5. Ignore other training	Uncertain
6. Maintenance costs are averages	Upward
7. Ignore increases in military pay	Upward

Finally, and perhaps most importantly, using either the CNA or ADSTAP productivity profiles also generates errors. We have argued that the ADSTAP profile almost surely gives an upward bias to our estimates of B. This is probably also the case with the CNA profile as well. In short, the errors in the productivity estimates (or the uncertainty surrounding these estimates) probably dwarf the errors our cost estimates introduce.

APPLICATIONS

ZONE A SELECTIVE REENLISTMENT BONUSES

Despite its rather pessimistic tone, we believe the preceding analysis can still assist the Navy in making decisions about bonus policy. Recall equation (3) from which we derived equation (5), which we estimated:

$$\frac{\overline{MP}_c}{\overline{E}_c + B} = \frac{\overline{MP}_f}{\overline{E}_f + T} \quad (3)$$

Equation (3) can be rearranged as follows:

$$\frac{\overline{MP}_c}{\overline{MP}_f} = \frac{\overline{E}_c + B}{\overline{E}_f + T} \quad (6)$$

The right-hand side of (6) can be estimated with reasonable confidence, but we have argued that the left-hand side cannot. By estimating the right-hand side of (6) only, we can say what the left-hand side *ought* to be to justify paying a bonus which implies a reenlistment premium of size B. However, the left-hand side of (6) reflects not only the larger product of a careerist, relative to a first-terminer, but also the fact that a "new" careerist will yield a larger number of expected years of service than will a first-terminer. We have therefore also estimated the ratio $\frac{\overline{TC}_c}{\overline{TC}_f}$. The term \overline{TC}_c is

the present value of the expected total costs of a careerists, which is simply the $\overline{E}_c + B$ which we have estimated for our earlier results. The term \overline{TC}_f , however, is the present value of the total costs for the *succession* of first-terminers necessary to provide the same years of service provided by the careerist. That is, instead of hiring careerists, the Navy could instead hire a new first-terminer every four years. The present value of the cost of doing so is represented by \overline{TC}_f .

Our estimates of the ratio $\frac{\overline{TC}_c}{\overline{TC}_f}$, which we have termed the "careerist premium," for seven ratings are presented in table 6.¹ What we show is how much *more valuable* a careerist must be than a first-terminer, on average, to justify paying a given bonus. For example, reading across the first row of table 6 we see that *average* careerist in the AC rating must be at least 13 percent more valuable to the Navy than the *average* first-terminer to justify paying a bonus of any size; he must be 35 percent more productive to justify paying a bonus of \$10,000 (which is roughly equivalent to an SRB 5 bonus for a four-year reenlistment).²

¹Because of our assumption that the Navy can hire a succession of first-terminers instead of a careerist no retirement costs have been attributed to first-terminers, while full retirement costs have been attributed to the careerist.

²Appendix E presents estimates of $\frac{\overline{TC}_c}{\overline{TC}_f}$ for ratings other than those in table 6. The figures in table 6 were calculated using a discount rate of 4 percent per year. Appendix E also presents calculations using a discount rate of 10 percent.

TABLE 6
CAREERIST PREMIUMS

Rating	Bonus size			FY 1975 SRB multiple
	Percent			
	0	\$6,000 (≈SRB 3)	\$10,000 (≈SRB 5)	
AC	13%	32%	35%	3
AE	40	59	62	4
AO	47	66	69	3
BT	20	39	42	5
EN	54	76	80	3
HT	51	68	71	5
OS	46	65	68	5

Source: See appendix E.

The figures in table 6 are, of course, roughly consistent with our earlier results since they are based on the same cost figures. They show that it is easiest to justify paying bonuses to ACs and most difficult to justify paying bonuses to ENs.

Calculations of the sort lying beneath the figures in table 6 are well within the current capabilities of the ADSTAP system.¹ Indeed, minor programming problems are probably the only bar to performing these calculations for all Navy ratings. Thus, even without accepting any given productivity profile, insight can be gained into which ratings are the most suitable candidates for reenlistment bonuses, based on current costs and continuation behavior.

In addition to costs and continuation behavior, decisions about bonus policy should also be based on the experience mix in specific ratings. There are a number of reasons for this. First, as we have outlined earlier, economic theory predicts that as the relative number of careerists in a rating rises, the marginal product of careerists will fall while the marginal product of first-termers will rise. This means, then, that in ratings that are undermanned by careerists, careerists will be relatively more valuable than in those that are not. When two ratings have similar careerist premiums (such as the AE and AO ratings in table 6), in the absence of any other information about the productivity of enlisted personnel, the rating with the lower percentage of careerists should receive a higher bonus.

A second reason for considering career manning deficiencies in determining bonus policy is the range of legal and budgetary constraints the Navy faces. Congress and DoD have effectively imposed constraints on the number of careerists the services can have. Although these constraints apply to the total enlisted force, violating them for one rating implies a lower than average ratio of careerists to first-termers for some other rating. Further, since the services are limited in the extent to which they can exchange bonus payments for other expenditures (such as pay or training costs) they face an effective budget constraint on bonus expenditures. Thus paying the maximum bonus in ratings where

¹These figures are also subject, of course, to the biases we discussed earlier arising from our cost estimates. Any error producing a bias in the reenlistment premium will act in the opposite direction on these figures. We thus would argue that our cost estimates downwardly bias the figures in table 6.

careerists are relatively populous may imply not paying bonuses in ratings where they are relatively scarce.¹

The preceding discussion should not be interpreted to mean a career manning deficiency alone should be sufficient grounds for paying a reenlistment bonus in a rating. Currently the Navy calculates career manning deficiencies by simply comparing the number of careerists in a rating with the number of billets written for careerists of that rating. This technique implicitly assumes that the required number of careerists is fixed and immutable and ignores the economic proposition that factors of production (first-termers and careerists in this context) can be used in variable proportions. Although this technique is therefore conceptually inappropriate it is unfortunately all that is currently possible. It would be desirable to know the experience mix (the ratio of careerists to first-termers rather than the ratio of careerists to careerist "requirements") in a rating and how changes in this mix affect the relative value of careerists and first-termers, but we have previously argued that this is not currently possible. The quantitative sensitivity of labor productivity to changes in the experience mix in the Navy is unknown. Further, the Navy does not know the experience mix of any given rating. First-termers are counted as members of a rating only after they have either completed an A School or passed the appropriate third-class petty officer's exam, thus ignoring individuals receiving O-J-T. This argument, then, suggests that information concerning career manning deficiencies should be used with great care in the determination of bonus policy.

There is yet another reason for not using career manning deficiencies as a sole criterion for granting reenlistment bonuses. Viewing the reenlistment bonus as a means for correcting career manning deficiencies can be shortsighted. If a bonus can quickly correct a career manning deficiency it may cause other problems, such as lessening promotion opportunities, which may weaken the effect of the bonus itself. More often, however, the bonus may take a considerable length of time to correct a career manning deficiency.

A numerical example may serve to strengthen this argument. Consider a hypothetical rating where careerists represent 25 percent of the force or 1,000 of a total of 4,000. Suppose that careerist requirements are written for 1,400 billets. If an SRB 5 bonus were paid to individuals reenlisting in this rating, it would be five years before the career force totaled the desired 1,400. This is illustrated in table 7. The illustration in table 7 is favorable to the effectiveness of the bonus, since few ratings have as much as three times as many first-termers as careerists. Further, because of first-term attrition, fewer than 25 percent of the first-termers in a rating will reach the first-term reenlistment point each year. Finally, we have allowed the population in the rating to grow each year, rather than holding it constant (by decreasing the number of first-termers as the number of careerists rises). Thus in general we would expect fewer first-termers reaching the first-term reenlistment point than do so in the illustration here. This means fewer reenlistments and a slower improvement in the career manning situation than is shown in table 7. Finally, note that even after the career manning deficiency has been corrected, the career force is "bottom-heavy" in the sense that all the additional careerists are concentrated in the 5th through 9th LOS cells. This may mean both slower promotion opportunities (which could lower the reenlistment rate) and a remaining shortage of supervisory personnel.

¹This discussion raises an issue we have not addressed—the relative value of personnel across ratings rather than within ratings. Thus while we have argued that an additional careerist appears to be much more "valuable" in the AC rating than in the EN rating, this comparison is made relative to first-termers in each rating, *not* relative to careerists in other ratings. We have thus ignored the rate at which the Navy is "willing" to exchange ACs for ENs.

TABLE 7
CAREER MANNING ADJUSTMENT INDUCED
BY A REENLISTMENT BONUS

LOS	Year					
	1	2	3	4	5	6
20	41	41	41	41	41	41
19	44	44	44	44	44	44
18	46	46	46	46	46	46
17	48	48	48	48	48	48
16	51	51	51	51	51	51
15	54	54	54	54	54	54
14	56	56	56	56	56	56
13	59	59	59	59	59	59
12	63	63	63	63	63	63
11	66	66	66	66	66	66
10	69	69	69	69	69	69
9	72	72	72	72	72	145
8	77	77	77	77	153	153
7	80	80	80	161	161	161
6	85	85	169	169	169	169
5	89	178	178	178	178	178
Total careerists	1,000	1,089	1,173	1,254	1,330	1,403
Number of first-termers	3,000	3,000	3,000	3,000	3,000	3,000
Number of first-termers reaching first-term reenlistment point	750	750	750	750	750	750
Number eligible to reenlist	638	638	638	638	638	738
Number reenlisting with SRB 5 bonus (reenlistment rate = 27.9 percent)	178	178	178	178	178	178
Number reenlisting when no bonus is paid (reenlistment rate = 13.9 percent)	89					
Assumptions: (1) Career continuation rate = .95						
(2) 25 percent of first-termers reach first-term reenlistment point each year (.25 x 3,000 = 750)						
(3) Reenlistment eligibility rate = 85 percent (.85 x 750 = 638)						
(4) First-term reenlistment rate was solved for by dividing 5th LOS cell by eligibles (89/638 = .139)						
(5) SRB 5 bonus doubles reenlistment rate (2 x 13.9 percent = 27.9 percent)						

If a bonus is not an entirely satisfactory technique for correcting career manning deficiencies, an alternative is to attempt to induce more transfers of personnel, from ratings which are overmanned by careerists, into those ratings where careerist shortages exist (lateral conversions). In the seven ratings we have studied, the cost of retraining individuals is lower than the cost of additional reenlistments (B) or the cost of procuring and training first-termers. This is shown in table 8.¹ Retraining is an even more attractive alternative if a good deal of the greater productivity of the careerist, relative to the first-termer, is due to his experience in the Navy, rather than his experience in a specific rating.

¹We have calculated these retraining costs on the basis of our earlier estimates of marginal A School costs and maintenance costs for a man in the 6th LOS cell in the appropriate rating. Maintenance costs have been pro-rated on the basis of the length of A School training (from reference 7).

TABLE 8
TRAINING COSTS

Rating	Cost of procuring and training first-termers	Cost of retraining careerists
AC	\$10,764	\$8,045
AE	9,041	7,559
AO	7,408	5,301
BT	5,861	2,836
EN	5,847	3,159
HT	7,801	6,448
OS	8,808	5,928

Lateral transfers become still more attractive when we consider that they serve as a "cure" for overmanning as well as for undermanning. As we argued earlier, Congressionally-imposed constraints on the number of careerists the services can have (if these constraints are effective) imply that career manning surplus in one rating *must* be associated with a career manning deficiency in at least one other rating. Thus all career manning deficiencies cannot be corrected, regardless of policy, unless there are no career manning surpluses. Also, overmanning in one rating, in terms of careerists, may imply not only a shortage of careerists in other ratings, but also a *general* shortage of personnel elsewhere (*both* first-termers and careerists). This can occur because the services face a constraint in terms of their total force. Finally, by transferring careerists out of overmanned ratings, the Navy benefits also because it is no longer paying for an "unnecessary" individual. Eliminating or lessening these consequences of careerist surpluses, then, considerably strengthens the case for lateral transfers.

ZONE B SELECTIVE REENLISTMENT BONUSES

We believe our analysis also has implications for the use of Zone B SRB bonuses. Zone B bonuses are payable to individuals with more than six, but less than ten years of service. This bonus is likely to have very little effect on continuation or retention behavior. Continuation rates for the sixth through tenth years average about 90 percent (see tables A-1 and B-1) and increasing this rate is not likely to be cheap. The pay elasticity for reenlistments from individuals in these year groups should be much lower than those we have estimated for first-term reenlistments and may be well below 1.0. This implies that even very large bonuses will have only very small effects. Further, since second-term reenlistment rates appear to be quite high to begin with, paying Zone B bonuses will involve paying bonuses to large numbers of individuals who would have reenlisted anyway. In short, widespread use of Zone B bonuses is unlikely to be particularly useful.

The argument in the preceding paragraph may not apply so strongly to specific ratings, but it is probable that it applies to a large fraction of the 18 ratings eligible for Zone B bonuses in FY 1975. In any event, to simply grant Zone B bonuses to the 18 ratings with the most severe career manning deficiencies (which appears to be essentially what was done) is not likely to make very efficient use of these funds.

Finally, it is probably not reasonable to argue that the Zone B bonus is necessary on the grounds that marginal reenlistments induced by the Zone A bonuses will otherwise be lost after the first reenlistment term. We have developed evidence (see appendix C) that individuals induced to reenlist

by the first-term reenlistment bonus are as likely to make a career of the Navy as are individuals who reenlist without a bonus.

There is, however, one instance where Zone B bonuses may prove to be useful and that is as a tool to encourage lateral conversions. We have argued that if reenlistment bonuses are viewed as a means of correcting career manning deficiencies, it is likely to be both a slow and expensive process. Thus lateral conversions may be a very attractive alternative. Currently, however, there is little incentive for individuals to opt for such conversions if they are beyond six years of service (and hence ineligible for Zone A bonuses).¹ Zone B bonuses could provide such an incentive if legally possible.

A final possible use of Zone B bonuses is as a substitute for the nuclear petty officer continuation pay. If a nuclear qualified petty officer extends or reenlists for two or more years beyond the six he is initially obligated for, he is entitled to a Zone A SRB which is calculated on the basis of the fifth and sixth years as well as the additional two or more years beyond the sixth year. For example, a nuclear petty officer assigned SRB multiple 5 who extends or reenlists through the eighth year of service, will receive a bonus equal to his monthly base pay times five (SRB multiple 5) times four (for the fifth through the eighth years of service). Thus a reenlistment for *two* years entitles him to a bonus calculated as if he had reenlisted for *four* years. This obviously serves as a powerful incentive (and, we should note, a very expensive one) for nuclear petty officers to remain in the Navy for eight or nine years. It also means that these individuals may not make a true first-term reenlistment decision until the eighth or ninth year of service. The nuclear petty officer continuation pay currently serves the function of inducing these individuals to stay in the Navy through the 11th or 12th year of service. After that, the lure of retirement pay is generally considered sufficient to keep nuclear petty officers until retirement. The Zone B SRB, if large enough, can obviously serve the same function the continuation pay now does.

We have not addressed the issue of ratings or NECs comprised of six-year obligors because of our judgment that these groups raise special, and in some cases unique issues. Because of the data problems outlined in appendix B, analysis of these groups is further complicated. Thus many of our results and conclusions cannot be routinely applied to problems generated by these groups.

¹The Navy currently has only one program to encourage rating transfers by individuals. The Selective Conversion and Reenlistment (SCORE) program applies to individuals with more than 21 months, but less than ten years of active duty. This program guarantees schooling. It also guarantees accelerated promotions, SRB, and proficiency pay, if the individual is otherwise eligible. For individuals with less than six years of service, this appears to be a very expensive program, since it effectively combines the costs of buying careerists with much of the costs of first-termers. The SCORE program offers little incentive to individuals with greater than six years of service, since they are ineligible for Zone A SRB, and proficiency pay is being phased out.

CONCLUSIONS AND RECOMMENDATIONS

The preceding analysis leads to a variety of conclusions and recommendations that we have classified into two broad groups. The first group contains immediate implications for bonus policy while the second addresses the data collection and research implications of our work.

BONUS POLICY

We have argued that using reenlistment bonuses to correct career manning deficiencies may be a slow and expensive process. We therefore recommend that the Navy take great care when using career manning deficiencies as a criterion for granting the use of bonuses, and actively seek to encourage a greater number of lateral conversions from ratings which are overpopulated by careerists to those that are underpopulated.

Among other things, the new Selective Reenlistment Bonus legislation has authorized payment of bonuses for individuals at the second-term reenlistment point, so-called Zone B SRBs. We have argued that there are only two possibly reasonable uses for this bonus: (1) to encourage lateral conversions, and (2) as a substitute for the nuclear petty officer continuation pay. We therefore recommend *against* the Navy using these bonuses, alone, to correct career manning deficiencies. We also recommend that the Navy consider using bonuses to encourage lateral conversions and the legality of such use under present law.

Current analytical techniques, given the information we have, cannot give definitive answers on which ratings should receive Zone A or Zone B bonuses. Nevertheless, computing "careerist premiums" as we have done in table 6 and appendix E can provide guidance. We believe doing so should be seriously considered by the Navy as part of the ADSTAP system. The utility of these estimates would be further enhanced if the errors in our cost estimates (see table 5) were lessened or eliminated. The information and data necessary to do so is probably all currently available.

DATA COLLECTION AND RESEARCH ISSUES

Given the variety of ways individuals can make positive recommitment decisions at the end of an enlistment contract, a "perfect" or unambiguous reenlistment rate is probably an impossibility. There are still improvements in the present system, however, which are possible and which, if adopted, would facilitate research of the kind described here as well as improve management of the enlisted force. First, except for purposes of estimating pay, there appears to be little justification for using Pay Entry Base Date (PEBD) data rather than Active Duty Base Date (ADBD) data. (See appendix B for a further elaboration of this argument.) Both continuation and retention statistics are most appropriately computed using ADBD data. Second, we can see no reason for counting six-year enlistees as reenlistments at the four-year point. Changing this procedure probably involves better tracking of individuals by type of enlistment. Third, more complete reporting of the length of extensions and reenlistments should be adopted. Length-of-recommitment data combined with reenlistment and continuation rates can provide a fairly accurate picture of the Navy's retention experience.

The Navy does not currently control or report the number of "undesignated enlisted personnel" working in specific ratings. Undesignated personnel are individuals (virtually all of whom are first-termers) who have neither attended an A School nor passed an exam for third-class petty

officer. Increased control may not be desirable, but better reporting of the assignments of non-rated personnel surely would be. Individuals receiving O-J-T are an important input to many ratings, and rating coordinators and other planners would benefit from knowledge of their numbers. Better reporting may, of course, prove to be expensive, but it is worth investigating.

We have argued that the productivity profiles used here are subject to a great deal of criticism. This is no less true of the ADSTAP profile. Nevertheless, it is being considered for use in optimization models designed to generate an "ideal" enlisted force. We recommend against such use at present. The ADSTAP profile, while representing a great deal of effort and care, is still very difficult to believe.

If our evaluation of the ADSTAP productivity profile is correct, this implies a serious need for research on the subject of enlisted productivity. It is difficult to know how much to pay for something without knowing how valuable it is. Yet that is precisely the position the services find themselves in with respect to personnel (and perhaps much hardware as well). This may be the most glaring deficiency in the knowledge the services can bring to the analysis of questions concerning compensation policy. This deficiency is, to a large extent, due to the absence of any measure of military output and the serious difficulties involved in creating one. This should not serve as a permanent bar to productivity studies, however, for the rewards to successful research are probably greater here than in any other area of manpower research.

Since research in this area is obviously difficult, instant answers should not be expected. Any single major effort is unlikely to produce definitive results. Progress will more probably be slow and piecemeal, with different elements of the puzzle coming from different sources. One direction from which results may come is the analysis of manpower requirements. This is, of course, another way of viewing the productivity question but it may provide some answers more easily. To date, it too has been a neglected area of research.

Finally, we have argued that much more needs to be known about the costs of training individuals within the Navy. This is true for both on-the-job and formal school training. We currently know neither the total costs of training nor how these costs change as either the number of trainees or the type of training changes.

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APPENDIX A
DATA AND ESTIMATION

This appendix presents detail on the sources and uses of the data lying behind the results presented in the text. It is organized in the same fashion as the section of the text headed "Data" (pages 5-14).

Continuation Behavior

The basic continuation data was taken from those rates prepared for the Billet Cost Model of the ADSTAP system. They are reproduced in table A-1. These rates are largely based on continuation behavior during the early 1960s. The reason for the high losses in year five (rather than year four which might be expected, since most first-term enlistment contracts are four years long) is short extensions carrying individuals beyond the fourth year until release can be effected, and the use of Pay Entry Base Date data. We have consequently adjusted the fifth-year losses to reflect this. (Fourth-year losses are not used in our calculations.) We have assumed that losses in year five are the same as those in year six, i.e., that the fifth-year continuation rate is the same as the sixth-year rate.

TABLE A-1
CONTINUATION RATES^a

Year	AC	AE	AO	BT	EN	HT	OS
1	.984	.999	.999	.984	.995	.999	.997
2	.915	.992	.981	.963	.984	.999	.980
3	.877	.928	.916	.863	.877	.769	.844
4	.783	.811	.808	.718	.761	.709	.750
5	.458	.350	.354	.284	.340	.334	.246
6	.838	.904	.901	.893	.889	.946	.874
7	.903	.938	.918	.910	.895	.939	.907
8	.953	.956	.958	.931	.935	.961	.956
9	.921	.937	.940	.876	.944	.964	.942
10	.925	.944	.960	.908	.936	.945	.915
11	.920	.913	.925	.920	.932	.931	.951
12	.975	.976	.959	.960	.963	.988	.946
13	.980	.966	.967	.977	.956	.954	.967
14	.971	.957	.987	.973	.966	.974	.967
15	.968	.988	.991	.978	.981	.968	.959
16	.999	.987	.999	.992	.948	.948	.999
17	.981	.981	.999	.942	.980	.967	.992
18	.992	.966	.988	.978	.979	.983	.972
19	.963	.961	.971	.953	.959	.925	.978
20	.746	.773	.747	.703	.743	.850	.717

^aFraction of individuals who started a year who are still in Navy at end of year.

Source: Bureau of Naval Personnel, Billet Cost Model, ADSTAP System.

For purposes of calculating expected costs and returns, we have assumed all losses in a given year occur at the end of the year. We also needed to know the retention rate from year four to year five in the absence of a bonus, for the purpose of calculating the expected costs and returns of a first-termer beyond the four-year point. The retention rate is simply the product of the reenlistment eligibility rate and the reenlistment rate. We assumed an eligibility rate of 85 percent

(see appendix B); the reenlistment rates were calculated on the basis of FY 1973 reenlistment rates and VRB multiples, assuming a pay elasticity of 3.0.

The Effect of Reenlistment Bonuses

Justification for the use of a pay elasticity of 3.0 can be found in appendix C and the text. Reenlistments rates in the absence of bonuses were computed using the constant elasticity formula

$$\frac{R_1}{R_0} = \left(\frac{E_1}{E_0} \right)^\eta$$

where η is the elasticity (=3.0), R_1 and E_1 refer to the reenlistment rate and earnings with a bonus, and R_0 and E_0 to the reenlistment rate and earnings without the bonus. Earnings and reenlistment rates were calculated from FY 1973 data.

Productivity of Enlisted Personnel

The development of the CNA productivity profile is presented in appendix D. The raw data for the ADSTAP productivity profile is presented as table A-2. The figures in table 1 were derived on the basis of the figures in table A-2 and the average time to advancement, taken from the Billet Cost Model of the ADSTAP system. These figures are shown in table A-3.

Maintenance Costs of Enlisted Personnel

Basic data was taken from the Billet Cost Model of the ADSTAP system. We subtracted the costs of reenlistment bonuses and retirement and first-term training costs from these figures. Costs in the first year were adjusted to include only those costs incurred after A School. The cost of the retirement annuity was based on an E-7 retiring with 20 years service and a life expectancy of 34 more years.

Training Costs

For our purposes, training costs can be divided into three categories: procurement costs, costs of delivering training, and costs of maintaining the trainee. Average procurement costs were assumed to be \$1,000 which is roughly the ratio of the Recruiting Command's budget to the number of accessions. Costs of delivered training for boot camp and formal skill training were taken from reference 7. These costs were inflated ten percent to account for the fact that they reflect FY 1972 costs. "Marginal" costs were assumed to be 75 percent of average costs of procurement and delivered training. Costs of maintaining the trainee were taken from the Billet Cost Model of the ADSTAP system.

Our assumption that marginal training costs are 75 percent of average costs requires further explanation. Assume that the Training Command's costs are described by a typical cost function. Then there will be both a long-run average cost (LRAC) curve and a long-run marginal cost (LRMC) curve which describe the Training Command's cost function. Typical LRAC and LRMC curves are illustrated in figure A-1. Associated with any LRAC curve is a family of short-run average cost (SRAC) curves, two of which ($SRAC_1$ and $SRAC_2$) are shown in figure A-1. Further, associated with any SRAC cost curve is a short-run average variable cost (SRAVC) curve and a

TABLE A-2

ADSTAP PRODUCTIVITY DATA
(Index, 100 = highest productivity)

Year	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
1	—	8	16	26	38	47	54	58	62
2	7	14	20	29	40	48	55	59	63
3	7	15	29	35	43	50	56	60	64
4	7	14	31	42	48	53	58	61	65
5	7	14	31	45	54	57	60	63	66
6	6	14	31	46	59	61	63	65	68
7	6	13	31	47	62	66	66	67	70
8	5	13	31	46	64	70	70	70	72
9	5	12	30	46	65	73	73	73	75
10	4	11	30	46	65	75	77	77	78
11	3	10	30	46	65	76	81	80	81
12	3	9	29	45	65	77	83	83	84
13	2	8	28	45	65	78	85	86	86
14	1	7	28	44	64	78	86	88	89
15	1	6	27	43	64	78	87	90	91
16	1	5	26	42	63	78	88	91	93
17	1	4	24	40	62	78	89	92	95
18	—	3	23	38	61	78	89	93	96
19	—	2	22	37	59	77	89	94	97
20	—	2	20	35	57	76	89	94	98
21	—	1	19	33	55	75	89	94	98
22	—	1	18	31	52	73	89	95	99
23	—	1	16	29	49	71	88	95	99
24	—	1	15	27	47	68	87	95	100
25	—	—	14	25	44	65	85	95	100
26	—	—	14	24	42	61	82	94	100
27	—	—	13	23	41	58	78	93	100
28	—	—	12	22	39	56	74	89	100
29	—	—	12	21	38	54	71	85	98
30	—	—	11	21	37	53	69	81	91
31	—	—	11	20	37	52	68	79	87

TABLE A-3

AVERAGE TIME TO ADVANCE, SELECTED RATINGS
(Years)

Paygrade	AC	AE	AO	BT	EN	HT	OS
E-2	0.4	0.4	0.4	0.4	0.4	0.4	0.4
E-3	1.2	1.2	1.2	1.2	1.2	1.2	1.2
E-4	2.2	2.2	2.2	2.4	2.4	2.3	2.2
E-5	2.9	3.6	3.6	3.8	4.8	3.7	3.3
E-6	10.9	10.1	8.8	11.2	10.5	7.2	7.9
E-7	15.7	15.6	15.8	15.5	15.8	15.6	14.3
E-8	18.7	16.7	18.1	17.0	17.5	16.5	16.0
E-9	22.8	21.3	20.7	19.3	19.3	18.3	18.9

Source: Bureau of Naval Personnel, Billet Cost Model, ADSTAP System.

short-run marginal cost (SRMC) curve. The SRAVC and SRMC curves associated with $SRAC_1$ are also shown in figure A-1.

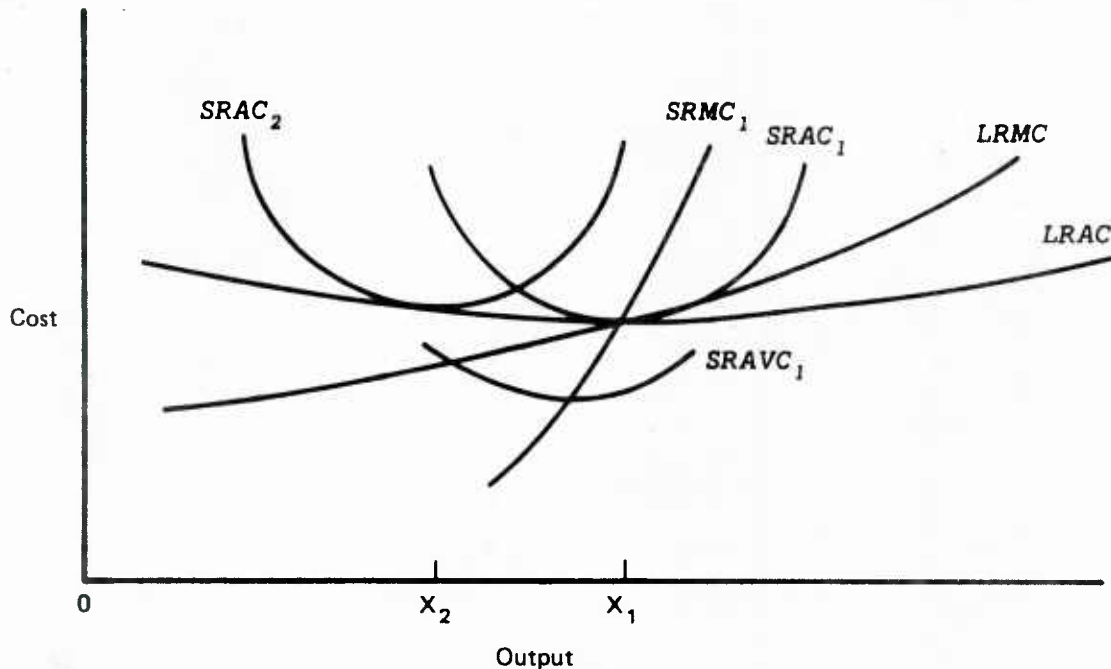


FIG. A-1: TRAINING COMMAND COST CURVES

Our purposes here require information about long-run *marginal* costs (points along LRMC in figure A-1), not information about average total or variable costs. If the calculations in reference 8, however, were based on experience in FY 1968 and FY 1969 (reference 8 is dated 4 September 1969), years in which the output of the training command was quite high, we can assume the Training Command was producing output OX_1 on cost curve $SRAC_1$, with average variable costs ($SRAVC_1$) 75 percent of average costs ($SRAC_1$), as reference 8 asserts. We have average costs from reference 7 which are based on FY 1972 experience, a year in which training output was substantially lower than FY 1969 output. Call FY 1972 output OX_2 . If the Training Command had correctly adjusted to this decreased load it would presumably have used fewer resources in FY 1972 than in FY 1969, and operated along $SRAC_2$. It appears, however, that it did not adjust, and used about the same resources in FY 1972 as it did in FY 1969. This implies that it was operating on cost curve $SRAC_1$ in FY 1972 also. Reference 9 estimates that current average costs may be over 30 percent higher than they need be if the Training Command were operating on $SRAC_2$ instead of $SRAC_1$. Since we know that $SRAC_2$ lies above LRMC, our assumption that marginal costs (on LRMC) are 75 percent of average costs ($SRAC_1$ not $SRAC_2$ because the Training Command has not adjusted to reduced student levels from FY 1969) may *overstate* true marginal costs. This would have the effect of biasing upward our estimates of the reenlistment premium (tables 2 through 5) and biasing downward our estimate of the careerist premium (table 7 and appendix E).

Discount Rates

Justification for our heavy reliance on the rate of 4 percent can be found in the text. We have also used a rate of 10 percent. The actual discounting was done from the middle of each year with the exception of year one. Training costs were not discounted and first-term maintenance costs (costs incurred after training is completed) were discounted from the end of the first year.

APPENDIX B

A CRITIQUE OF NAVY RETENTION STATISTICS*

*An earlier version of this appendix was released as reference 11.

The advent of the All-Volunteer Force has, and will continue to have, far-reaching and significant influence on all phases of Navy policy and planning. Nowhere has the AVF had greater impact than in the procurement and retention of enlisted personnel. If the Navy is to wisely apply the enlistment and selective reenlistment incentives at its disposal, if policy-makers are to make intelligent decisions regarding training investments, retirement, and other factors which determine the size and distribution of the force, then surely one of their most crucial requirements is an accurate knowledge of the numbers and expected continuance behavior of the enlisted population.

It is the purpose of this paper to describe the concepts which the Bureau of Naval Personnel (BuPers) now uses to measure both current inventories of personnel on board and to track the continuance decisions of the enlisted force.

Inventories and Continuation Rates

The current stock of enlisted personnel is generally given as the number of individuals in each paygrade by length of service (LOS). The Navy uses this inventory data in calculating "career manning ratios" (the number of individuals with 4 to 31 years of service divided by career requirements) and "top-six ratios" (the proportion of total personnel in paygrades E-4 through E-9). Continuation rates (described below) and probabilities of advancement may also be derived from this data.

The particular LOS cell in which an individual is placed may be determined by either Active Duty Base Date (ADBD) or Pay Entry Base Date (PEBD). The former refers to the date the individual actually commences his active service, the latter refers to the date on which pay for longevity purposes is based. For most individuals these dates are identical. However, during periods of "accession smoothing" or other instances where individuals enter reserve programs prior to commencing active duty, PEBD precedes ADBD. The consequences of this distinction appear in the calculation of continuation rates.

Continuation rates are calculated by dividing the number of individuals in the i th LOS cell in year t by the number of individuals in the $(i-1)$ th LOS cell in year $t-1$. For example, if there are 100 individuals in the third year of service in a given year and we observe that in the next year there are 80 individuals with four years of service, then the third-year continuation rate for this cohort is $80/100$, or 80 percent. PEBD data introduces a bias into observed continuation behavior. Many first-term EAOS-related losses appear in the fifth year of service rather than in year four where they properly belong. The magnitude of this bias is shown in table B-1. Overall Navy continuation rates for the period FY 1968-73, using ADBD and PEBD data, are compared. Attention is drawn to the often large differences in early LOS cells. Consider, for example, the 1st LOS cell. It shows a continuation rate greater than 1.0 when calculated from PEBD data. This illogical result derives from the fact that many accessions have as much as six months longevity for pay purposes at the *beginning* of their first year of service, because of delayed entry to active duty after signing an enlistment contract. Thus at the end, for example, of FY 1974 an individual may not be on active duty, yet by the end of FY 1975 he will be in the 2nd LOS cell even though he has less than one year of active duty. This individual thus is never counted in the 1st LOS cell, thereby underestimating the denominator of the continuation rate and overestimating the continuation rate itself.

Apart from the ADBD-PEBD distinction, other biases may appear when dealing with continuation rates for individual ratings. When non-rated personnel become identified strikers, they appear

TABLE B-1

A COMPARISON OF CONTINUATION RATES
FOR ACTIVE DUTY BASE DATE (ADBD) AND
PAY ENTRY BASE DATE (PEBD) DATA,
AVERAGE FY 1968-73

Years of service completed	Continuation rates	
	ADBD	PEBD
1	.861	1.207
2	.695	.894
3	.797	.748
4	.193	.308
5	.828	.697
6	.912	.910
7	.879	.878
8	.878	.872
9	.734	.895
10	.913	.896
11	.959	.948
12	.968	.960
13	.985	.966
14	.983	.972
15	.965	.974
16	.984	.979
17	.994	.985
18	.803	.980
19	.622	.818
20	.477	.606
21	.560	.685
22	.603	.704
23	.769	.732
24	.800	.761
25	.822	.815
26	.756	.773
27	.790	.777
28	.885	.856
29	<i>a</i>	.859
30 and over	<i>a</i>	.914

^aUnavailable.

as gains to ratings. Lateral movement between ratings lowers the continuation rate in one rating and raises it in another although overall Navy continuation has not changed. Finally, direct procurement of personnel to petty officer status imparts an upward bias to continuation rates.

Reenlistment Rates

Reenlistment rates are the primary means by which the Navy measures its degree of success in retaining enlisted personnel. Given that the most crucial decision (from the Navy's viewpoint) is at the end of the first term of service, the most widely available reenlistment rates are for first-termers (generally those with four years of service). Reenlistment rates are the percentage of those eligible to reenlist who make a positive continuance decision. At the end of a term of service, an individual

may reenlist for two to six years or extend his original contract for one to 48 months. Extensions of 24 months or more are counted along with all reenlistments in the numerator of the reenlistment rate.

Given the Navy criterion that extensions of less than two years are not counted in the reenlistment rate, it appears that reenlistment rates underestimate first-term continuance behavior. Table B-2 presents the percentage distribution of lengths of first-term recommitment for the period FY 1970-73. Among 4YOs, about 40 percent of recommitments are not reflected in reported first-term reenlistment rates (FTRR).

TABLE B-2
PERCENTAGE DISTRIBUTION OF LENGTHS OF
FIRST-TERM RECOMMITMENT BY OBLIGATION,
FY 1970-73

		Fiscal year			
		1970	1971	1972	1973
Four-year obligors (4YOs)	<2 years	.432	.388	.420	.381
	=2 years	.050	.055	.063	.074
	>2 years	.518	.556	.517	.546
4YOs in 6YO ratings	<2 years	.290	.177	.202	.220
	=2 years	.188	.227	.269	.339
	>2 years	.522	.596	.529	.441
Six-year obligors only (6YOs)	<2 years	.021	.023	.057	.103
	=2 years	.469	.587	.590	.486
	>2 years	.510	.391	.352	.411

Six-year obligors are treated separately in table B-2 since the Navy usually records the six-year commitment as a four-year enlistment plus a two-year extension. When these individuals pass their fourth year of service, the 24-month extension is counted as a first-term reenlistment. At the six-year point, any further commitment of two or more years is again counted as a first-term reenlistment. Consequently, ratings which contain 6YOs have first-term reenlistment rates which are biased upward.

The task of obtaining an unbiased measure of continuance behavior among six-year obligors is complicated by the presence of 4YOs in the same ratings. Furthermore, it is not clear that (in the process of data collection) individuals are properly identified as to the length of their initial obligation. Thus, the observed FTRR of ratings containing 6YOs give very little information about the Navy's success in retaining individuals beyond the first term.

The FTRR reported by the Navy for ratings which include 6YOs contain at least three distinct groups of individuals: (1) four-year obligors at the fourth year of service, (2) six-year obligors at the fourth year of service, and (3) 6YOs at the sixth year of service. The reenlistment rate of the second group is, by the Navy's definition, 100 percent since all 6YOs must execute at least a 24-month extension at the four-year point. Individuals in the first and third categories might be expected to conform more closely with the Navy-wide average with respect to their continuance behavior.

In table B-3, two alternative adjustments are made to the reported FTRR of 6YOs in an attempt to approximate their reenlistment behavior. In the first adjustment, of those who are declared eligible to reenlist, only those individuals whose recommitment takes them beyond the sixth year of service are counted in the numerator. In the second adjustment, individuals who execute 24-month extension at the fourth year of service are removed from the numerator of the Navy's reported reenlistment rates. Similar results are obtained from both adjustments: for FY 1972 and FY 1973, the FTRR of 6YOs appear much closer to those of other ratings.¹

Using the corrected reenlistment rates of 6YOs from table B-3, the overall FTRR of each rating is reconstructed in table B-4. Given the reported reenlistment rate from the familiar "green book," (reference 12) 6YO eligibles and reenlistees are subtracted, yielding the inferred reenlistment rate of 4YOs in the rating. To this we add the adjusted number of 6 YO eligibles and reenlistees. The result can be viewed as an upper limit to the "true" reenlistment rates of 6YO ratings. There appears to be a strong upward bias to the inferred 4YO FTRR. This leads us to believe that, at least in some ratings, many individuals are not correctly identified as 6YOs.

Individuals may reenlist prior to the expiration of their term of service (ETS). Reenlistment rates which count these early decisions in the month in which they occur are termed "unadjusted" by the Navy. "Adjusted" reenlistment rates move the decision forward to coincide with the original ETS. Any advantage that may accrue from this adjustment is at least partially offset by the fact that reenlistments which occur after an individual's ETS are not counted in the proper month when the adjusted reenlistment rate is calculated. In FY 1973, 682 reenlistments were of individuals more than 24 hours beyond, but still within three months of their ETS. In that same year, 4,426 (or 8.5 percent) of reenlistments were of individuals more than three months beyond their ETS.

Reenlistment rates may be increased by increases in the number of reenlistees (the numerator) or by decreases in the number of individuals eligible to reenlist (the denominator). Table B-5 gives the number of first term ineligibles as a percent of total separations for the period FY 1968-73. The percentage of ineligibles increased dramatically in FY 1971 and has remained at a relatively high level to the present.

The sensitivity of the reenlistment rate to changes in the numbers of eligibles can be seen in table B-6. Here we compare the relatively large increase in the first-term reenlistment rate in construction ratings between FY 1972 and FY 1973 with changes in the number of eligibles. Note that there is little or no change in the number of individuals who actually reenlist.

In FY 1971, a BuPers instruction required that for an individual to be declared eligible to reenlist he must have passed the appropriate E-4 examination. At the present time, commanding officers may waive this provision. However, it appears that individuals who have not been promoted to E-4 have a relatively low probability of being declared eligible to reenlist. For example, in FY 1975, while only five percent of those who had passed the E-4 examination were ineligible to reenlist, 54 percent of those who had not yet passed the examination were ineligible to reenlist.

To adjust for changes in the number of individuals eligible to reenlist, a "retention rate" is sometimes calculated. The retention rate uses the same numerator as the reenlistment rate but has total separations as its denominator. This is a DoD statistic and is not widely used within BuPers.

¹As noted on page 7, 6YOs are now counted as career reenlistments at the six-year point. Thus, further adjustments would be necessary to correct reenlistment rates for years after FY 1973.

TABLE B-3
ADJUSTED FTRR OF SIX-YEAR OBLIGORS

Rating	FY 1972			FY 1973		
	FTRR ^a	Adjusted FTRR ^b	Adjusted FTRR ^c	FTRR ^a	Adjusted FTRR ^b	Adjusted FTRR ^c
EW	1/1 = 1.000	1/1 = 1.000	1/1 = 1.000	20/25 = .800	10/25 = .100	10/25 = .400
STG	176/238 = .739	61/238 = .256	69/238 = .290	152/224 = .680	78/224 = .348	76/224 = .339
STS	152/168 = .904	64/168 = .381	64/168 = .381	160/191 = .840	70/191 = .366	65/191 = .340
ETN	830/1025 = .810	409/1025 = .399	407/1025 = .397	648/912 = .711	316/912 = .346	242/912 = .265
ETR	941/1120 = .840	282/1120 = .252	280/1120 = .250	520/788 = .660	244/788 = .310	170/788 = .216
DS	292/352 = .830	107/352 = .304	86/352 = .244	98/172 = .570	98/172 = .570	53/172 = .308
EM	291/404 = .720	123/404 = .304	106/404 = .262	360/444 = .811	141/144 = .318	124/444 = .279
IC	113/171 = .661	36/171 = .211	30/171 = .175	98/132 = .742	53/132 = .402	44/132 = .333
FTB	176/179 = .983	124/179 = .693	124/179 = .693	168/181 = .930	71/181 = .392	63/181 = .348
FTG	221/254 = .870	61/254 = .240	75/254 = .295	127/219 = .580	67/219 = .306	63/219 = .288
FTM	316/471 = .671	88/471 = .187	82/471 = .174	130/288 = .451	56/288 = .194	34/288 = .118
MT	322/343 = .940	219/343 = .638	217/343 = .633	185/203 = .911	92/203 = .453	87/203 = .429
GMM	85/103 = .830	31/103 = .301	31/103 = .301	53/99 = .540	43/99 = .434	34/99 = .343
MM	604/785 = .770	214/785 = .273	180/785 = .229	755/1006 = .750	467/1006 = .464	419/1006 = .417
CTM	240/316 = .760	72/316 = .228	74/316 = .234	89/165 = .540	52/165 = .315	23/165 = .139
Total	4859/6200 = .784	2013/6200 = .325	1877/6200 = .303	3626/5367 = .676	2037/5367 = .380	1564/5367 = .291

^aSource: E211 Report.

^bNumerator: (LOS + LOR) > 6.

^cNumerator: (Reenlistees) - (24-month extensions at LOS 4).

TABLE B-4
ADJUSTED FTRR OF SIX-YEAR OBLIGOR RATINGS

Rating	Observed FTRR	6YO FTRR	Inferred 4YO FTRR	Adjusted 6YO FTRR	Adjusted FTRR of rating
FY 1972					
EW	7/7 = 1.000	1/1 = 1.000	6/6 = 1.000	1/1 = 1.000	7/7 = 1.000
STG	422/708 = .596	176/238 = .739	246/470 = .523	69/238 = .290	315/708 = .445
STS	174/325 = .535	152/168 = .904	22/157 = .140	64/168 = .318	86/325 = .265
ETN	1486/1193 = .746	830/1025 = .810	656/968 = .678	407/1025 = .397	1063/1993 = .533
ETR	1413/1745 = .810	941/1120 = .840	472/625 = .755	280/1120 = .250	752/1745 = .431
DS	337/413 = .816	292/352 = .830	---	86/352 = .244	131/413 = .317
EM	750/2893 = .259	291/404 = .720	459/2489 = .184	106/404 = .262	565/2893 = .195
IC	297/1229 = .242	113/171 = .661	184/1058 = .174	30/171 = .175	214/1229 = .174
FTB	177/180 = .983	176/179 = .983	---	124/179 = .693	124/179 = .693
FTG	459/723 = .635	221/254 = .870	238/469 = .507	75/254 = .295	313/723 = .433
FTM	458/655 = .699	316/471 = .671	142/184 = .772	82/471 = .174	224/655 = .342
MT	329/349 = .943	322/343 = .940	---	217/343 = .633	217/343 = .633
GMM	131/201 = .652	85/103 = .830	46/98 = .469	31/103 = .301	77/201 = .383
MM	1122/3749 = .299	604/785 = .770	518/2964 = .175	180/785 = .229	689/3749 = .186
CTM	411/512 = .803	240/316 = .760	---	74/316 = .234	245/512 = .479
FY 1973					
EW	48/57 = .842	20/25 = .800	28/32 = .875	10/25 = .400	38/57 = .667
STG	395/878 = .450	152/224 = .680	243/654 = .372	76/224 = .339	319/878 = .363
STS	193/328 = .588	160/191 = .840	33/137 = .241	65/191 = .340	98/328 = .299
ETN	1150/1906 = .603	648/912 = .711	502/994 = .505	242/912 = .265	744/1906 = .390
ETR	1055/1629 = .648	520/788 = .660	535/841 = .636	170/788 = .216	705/1629 = .433
DS	183/263 = .696	98/172 = .570	---	53/172 = .308	138/263 = .525
EM	836/2436 = .343	360/444 = .811	476/2019 = .236	124/444 = .279	600/2436 = .246
IC	253/1159 = .218	98/132 = .742	155/1027 = .151	44/132 = .333	199/1159 = .172
FTB	166/179 = .927	168/181 = .930	---	63/181 = .348	63/181 = .348
FTG	332/973 = .341	127/219 = .580	205/754 = .272	63/219 = .288	268/973 = .275
FTM	378/580 = .652	130/288 = .451	248/292 = .849	34/288 = .118	282/580 = .486
MT	186/205 = .907	185/203 = .911	---	87/203 = .429	87/203 = .429
GMM	115/313 = .367	53/99 = .540	62/214 = .290	34/99 = .343	96/313 = .307
MM	1280/3702 = .346	755/1006 = .750	525/2696 = .195	419/1006 = .417	944/3702 = .255
CTM	216/303 = .713	89/165 = .540	---	23/165 = .139	150/303 = .495

TABLE B-5
FIRST-TERM INELIGIBLES AS A
PERCENT OF TOTAL SEPARATIONS,
FY 1968-73

Fiscal year	Number ineligible	Total separations	Percent ineligible
1968	26,688	102,331	26.1
1969	29,420	106,305	27.7
1970	50,056	174,403	28.7
1971	64,900	143,110	48.8
1972	53,570	127,008	42.2
1973	49,310	127,148	38.8

TABLE B-6

FIRST-TERM REENLISTMENT RATE AND
ELIGIBILITY CHANGES FOR SELECTED
CONSTRUCTION RATINGS

Rating	FY 1972			FY 1973		
	Eligibles	Reenlistees	FTRR	Eligibles	Reenlistees	FTRR
BU	691	48	6.9	261	48	18.4
CE	393	37	9.4	259	29	11.2
CM	460	47	10.2	172	42	24.4
EA	331	3	0.9	104	7	6.7
EO	572	53	9.3	342	64	18.7
SW	218	13	6.0	36	5	13.9
UT	253	15	5.9	122	36	29.5
Total	2,918	216	7.4	1,296	231	17.8

First-term and career reenlistment rates are given in a variety of formats. Depending on the use to which they will be put, reenlistment rates are available by rate (paygrade), rating, length of service, Naval Enlisted Classification (NEC), VRB multiple, pro pay level, and possibly others. Some "second-term" reenlistment rates are available, but these have generally been found to be incomplete. In particular, second-term reenlistment rates for the period FY 1970-72 covered the months of July through December for each year; observations for January through June are unaccountably missing. Since enlistments and reenlistments are not evenly distributed over a given year (e.g., relatively more individuals enlist at the end of the school year than in other months), we cannot extrapolate the second-term reenlistment data.

Conclusion

Table B-7 summarizes the findings of this paper. The primary retention statistic affected by each of the problems discussed, as well as the direction of bias, is shown.

TABLE B-7

SUMMARY OF BIASES IN NAVY RETENTION STATISTICS

Item	Affects	Direction of bias
1. PEBD	Continuation rates	Up in early LOS cells; direction erratic in later LOS cells
2. Identifying strikers	Continuation rates	Up
3. Lateral conversion	Continuation rates	Up or down by rating
4. Direct procurement of petty officers	Continuation rates	Up
5. Extensions of less than two years not counted in reenlistment rates	Reenlistment rates	Down
6. Treatment of 6YO reenlistments	Reenlistment rates	Up
7. Broken-service reenlistments	Reenlistment rates	Down
8. Increase in number of ineligible	Reenlistment rates	Up
9. Decrease in number of eligibles	Reenlistment rates	Up

The ability of the BuPers reporting system to accurately collect enlisted manpower information is complicated by the mix of initial contracts and the variety of means by which an individual may make positive continuance decisions. Although the enlisted force beyond the first term behaves as if so-called "open-ended" contracts existed, this by no means simplifies the task of keeping track of individual enlistments, reenlistments, and extensions.

However, it appears that a great deal of progress could be made toward standardization of the concepts used by BuPers in reporting retention data. For example, except for planners who are concerned with budgeting manpower pay and allowances, only Active Duty Base Date should be used in constructing inventories and continuation rates. Care should be exercised in the use and interpretation of reenlistment rates. The practice of automatically counting 24-month extensions of six-year obligors at the four-year point as a reenlistment should be reviewed. Finally, in addition to the number of reenlistments and extensions, close attention should be paid to the lengths of recommitment.

Failing to develop more precise methods of reporting retention information, planners should at least be aware of the problems involved in using current Navy retention statistics.

APPENDIX C

THE EFFECTS OF REENLISTMENT BONUSES

This appendix summarizes the results of our research into the effects of the Variable Reenlistment Bonus (VRB). A complete description of this research and its methodology, including data and statistical procedures, can be found in reference 13.

Reenlistment bonuses are designed to maintain an adequate supply of experienced personnel in the military. Through FY 1974, all individuals reenlisting for the first time received a regular reenlistment bonus (RRB). Though individuals can recommit from 30 days up to six years, only those recommitting for two years or more are counted as reenlistments and eligible for the bonus. The RRB could be as high as \$2,000 depending upon base pay and length of recommitment. VRB was awarded, in addition to RRB, between FY 1966 and FY 1974. VRB multiples from zero to four were assigned to each rating. The VRB awarded was the product of the RRB and the multiple. Beginning in FY 1975, RRB and VRB were replaced by the selective reenlistment bonus (SRB). The dollar value of the bonus is computed exactly as VRB with the multiples now ranging from zero to six. With the elimination of RRB, many individuals now receive no bonus for reenlisting.

We studied the effects of VRB, though the general findings are equally applicable to SRB. First-term reenlistments, lengths of first-term recommitments, and second-term reenlistments were examined. The prime target of VRB is the first-term reenlistment rate. It is the criterion employed by the Navy and DoD to measure the success or failure of VRB. An alternative way of measuring the effect of VRB is to examine its impact on man-year recommitments. For example, an individual who would extend for one year without VRB and reenlist for five years with VRB can be viewed as an additional reenlistment or as a recommitment for four additional years. To measure the additional man-year commitments, we analyzed the length of recommitments. Finally, we examined the career commitment of VRB-induced reenlistees. A proxy for second-term reenlistment rates was used for this purpose.

Ratings (occupations) were the units of observation in our analysis. Ratings with six-year obligors (6YOs), nondesignated enlisted personnel, and stewards were excluded from the study. Despite the prevalence of lateral entry into construction ratings, it was generally found that the inclusion of these ratings did not alter the findings.

The statistical analysis was carried out on the first differences of variables between years. That is, we sought to explain changes in first-term reenlistment rates, lengths of recommitment, and second-term reenlistment rates from one year to the next. This approach resulted from the scarcity of data that was specific to the individual ratings. We assumed non-VRB variables changed uniformly across ratings. Given the models and assumptions underlying them, this simplification is completely rigorous.

The findings on the effect of VRB on first-term reenlistment rates are based on three time intervals: FY 1965-67, FY 1968-69, and FY 1971-72. The effect of changes in VRB on changes in reenlistment rates was estimated from a least squares regression procedure. The results are reported in table C-1 for two models. The models differ in their specification of how VRB affects reenlistment rates. Columns (1) and (3) indicate the effect of a \$1,000 bonus on reenlistment rates. These numbers are percentage point increases. For example, in FY 1971-72 a \$1,000 increase in VRB increased reenlistment rates 1.21 percentage points according to the linear model. A multiple of one was equal to \$2,000 for most individuals; ratings with this size multiple had reenlistment rates 2.42 percentage points higher than they would have had with a zero multiple. The decline of the values in columns (1) and (3) reflect the effect of inflation. Combining all the intervals for the linear model, a \$1,000 bonus increased reenlistment rates by 1.38 percentage points. Given

continued inflation, however, the FY 1971-72 estimates would be an upper bound for the effect of VRB presently, and a figure as low as 1.00 percentage point per \$1,000 bonus appears more reasonable.

TABLE C-1
THE EFFECT OF VRB ON FIRST-TERM REENLISTMENT RATES

Interval	Linear model		Logit model	
	(1) $\frac{\Delta RR}{\Delta 1000}$ (percent)	(2) Elasticity at mean	(3) $\frac{\Delta RR}{\Delta 1000}$ (percent)	(4) Elasticity at mean
FY 1965-67	1.74	2.27	1.68	2.20
FY 1968-69	1.63	3.62	1.38	3.07
FY 1971-72	1.21	4.04	1.27	4.24

The elasticity is the percentage change in reenlistments divided by the percentage change in wages. Wages and reenlistments are measured at their means for each interval. The wages include base pay, the regular reenlistment bonus, variable reenlistment bonus, and the estimated value of basic allowances for quarters and subsistence. The higher elasticities at the mean reflect higher mean wages and lower reenlistment rates in the latter periods.

The analysis of lengths of recommitment is based on data for fiscal years 1970 through 1973. Results for FY 1971-72 and FY 1972-73 are reported in table C-2. The estimates are derived from regression analysis. The effect of an increase of one in the VRB multiple is in columns (1) and (3). This is the effect in the first year. In following years, the effect of the increase is slightly weaker as shown in columns (2) and (4). For example, in FY 1971-72, according to the linear model, an increase of one in the VRB multiple increased the average length of recommitment 0.463 years in the first year following the increase in VRB. It increased the average length of recommitment only 0.315 years in subsequent periods. The difference results because both the level and change in VRB affects the length of recommitment. The positive effect of the increase in the VRB multiple is consistent with the hypothesis that individuals expect the increase to be followed by a decrease. Since a bonus can only be awarded once, individuals recommit for over two years to become eligible for the bonus. In the period after the increase, the length of recommitment declines but remains significantly above that of the period prior to the VRB change.

TABLE C-2
THE EFFECT OF VRB ON LENGTH OF RECOMMITMENT IN PERIOD OF CHANGE AND FOLLOWING PERIODS

Interval	Linear model		Logit model	
	(1) $\frac{\Delta LOR_{\phi}}{\Delta Multiple}$	(2) $\frac{\Delta LOR_1}{\Delta Multiple}$	(3) $\frac{\Delta LOR_{\phi}}{\Delta Multiple}$	(4) $\frac{\Delta LOR_1}{\Delta Multiple}$
FY 1971-72	.463	.315	.564	.496
FY 1972-73	.588	.463	.604	.411

The recommitment rate is included as an explanatory variable in the analysis of length of recommitment. The recommitment rate is defined as the total number of extensions and reenlistments divided by the number eligible to reenlist. As additional individuals recommit, we expect average length of recommitment to decline. That is, marginal individuals are expected to recommit for shorter periods than intramarginal individuals. This expectation was borne out in the empirical analysis.

Finally, we asked whether the VRB significantly affects retention after the first-term reenlistment point. That is, are individuals who are induced to reenlist by the VRB less likely to stay for a 20-year career than those who are not? Second-term reenlistment rate data was not of sufficient quality to warrant its use for this purpose. As a proxy, continuation rates between the sixth and 11th years were examined. This was justified on the following grounds. Virtually all individuals beginning the sixth year of service (ignoring 6YOs) have made their first positive reenlistment decision, and will also have made their second-term reenlistment decision by the beginning of the 11th year of service. If losses other than those at the expiration of obligated service (reenlistment points) do not systematically vary across ratings (a reasonable assumption), then differences in continuation rates from the sixth to 11th years of service will reflect differences in second-term reenlistment rates. No relationship was found between the awarding of VRB and the continuation of people through the 11th year of service. Since most individuals staying through the 11th year remain until at least the 20th year, we concluded that VRB-induced individuals are as likely to be careerists as those not induced by VRB.

Based on this analysis, we conservatively estimate that 2,154 of the 17,053 first-term reenlistments in FY 1972 were induced by VRB. Additional man-years committed for in FY 1972 were 9,216. Over a 27-year period, the Navy will gain 16,488 additional man-years from these individuals. Though the gain appears sizeable, the final evaluation of VRB rests on its cost-effectiveness relative to alternative wage schemes.

APPENDIX D
THE CNA PRODUCTIVITY PROFILE ESTIMATES*

*This is a corrected version of a paper released earlier as reference 14.

The Navy makes important decisions in determining which persons in the force should receive special pay, how much they should receive, and how rapidly promotions should occur in each rating (occupation). In order to solve these problems analytically, estimates must be made of the supply response that can be expected from additional amounts of pay for each category of personnel, the additional costs the Navy incurs when personnel turnover increases by a given amount in each category, and the contribution to Navy effectiveness made by an additional person in each category.

Considerably more analytic effort appears to have gone into estimating supply elasticities and turnover costs than into the problem of estimating the marginal contribution of a person in each occupation and experience category. Moreover, a review of previous research to estimate the relative effectiveness of an additional person in each personnel category raises serious questions as to whether the methodology that has been used is the most appropriate. We attempt here to assess the importance of having accurate estimates of relative effectiveness, to review the methods of previous studies that make these estimates, and to set forth an alternative methodology for estimating relative effectiveness.

Relative Effectiveness as a Determinant of Pay

Manpower effectiveness is maximized under a given personnel budget whenever the personnel are combined in such a way that the marginal contribution produced by an extra dollar spent on any occupation and experience category is equal to the marginal contribution of an extra dollar spent on every other category. If the ratio of marginal personnel effectiveness to personnel cost is not constant across these categories, then costs can be reduced by employing more of the persons in these categories where the ratio is higher while using fewer of the persons in the other categories. Thus, the determination of how much to pay a person in each category depends, in part, upon the relative effectiveness of that person.

Before attempting to incorporate accurate estimates of relative effectiveness into the determination of military pay schedules, however, it is appropriate to attempt to understand the degree to which the determination of optimum pay is sensitive to errors in the estimates of, or assumptions about, relative effectiveness. We can do this by analyzing a simple steady-state representation of any given Navy rating. We start with the identity which states that the steady-state stock of personnel in any rating is equal to the annual accessions to that rating multiplied by the number of years that each such accession can be expected to serve in that rating:

$$S_j \equiv A_j \cdot \sum_{i=0}^n P_{ij} , \quad (D-1)$$

where S_j is the constant stock of personnel in occupation j , A_j is the number of annual accessions required to maintain that occupation at the level S_j , and where P_{ij} is the probability that an accession to occupation j in year 0 will be in the occupation in year i .

We then incorporate the fact that the productivity of a person in each occupation varies by his years of experience in that occupation. To do this, we rewrite (D-1) as

$$S_j' \equiv A_j \cdot \sum_{i=0}^n (P_{ij} \cdot E_{ij}) \quad , \quad (D-2)$$

where S_j' is the stock of fully effective personnel equivalence units in occupation j , and where E_{ij} is the index of relative effectiveness associated with the average person in experience year i of occupation j .

It should be obvious from the way in which P_{ij} and E_{ij} enter (D-2) that an a percent error in the estimate of the relative effectiveness of a person in category i,j will produce the same error in the measurement of S_j' as will an a percent error in the estimate of the extent to which additional pay given to persons in i,j will increase their retention probability P_{ij} . Hence, it is as important to have accurate estimates of E_{ij} as it is to have accurate estimates of pay elasticities for category i,j .

Review of Previous Estimates of Relative Effectiveness

A review of the literature has revealed four previous attempts to construct the optimal experience mix for military personnel using relative effectiveness estimates. The first of these attempts was by Gorman Smith (reference 1), the second by Franklin Fisher and Anton Morton (reference 15), the third by K. Kim, *et. al.* (reference 16), and the fourth by B-K Dynamics, Inc. (reference 17) for the ADSTAP system. Other attempts to determine efficient pay schedules have made simplifying assumptions about the relative effectiveness of each category of personnel.¹

Smith's (reference 1) method consisted of interviewing enlisted supervisors, in each of 22 major occupational specialties in the Army, to establish the length of time they think is needed to bring a new trainee up to the level of a fully effective journeyman. From these data, Smith estimated the effectiveness of a first-term enlisted man, relative to a careerist, in each occupational specialty.

Fisher and Morton (reference 15) partitioned the enlisted force into four experience categories, as distinct from the two that Smith created. These were "basic" (enlisted paygrades E-1 to E-3), "apprentice" (E-4), "journeyman" (E-5 and E-6), and "chief" (E-7 to E-9). Over 100 enlisted supervisors in the Navy were then asked to estimate various alternative combinations of these four experience classes that would maintain an occupational group at a given level of effectiveness. From these responses, Fisher and Morton constructed relative effectiveness indexes for nine activity types and six occupational groups.

Kim's (reference 16) determination of the optimal experience mix was based upon Smith's estimates of relative effectiveness and his own estimates of enlisted supply elasticities.

B-K Dynamics (reference 17) estimated a set of "utility factors" from a survey of Navy officers and senior enlisted men, the results of which were combined using a Delphi technique. The

¹For example, the Gates Commission estimated pay necessary to maintain the force at given levels, without explicit regard to the full implications of different experience mixes upon force effectiveness. While this estimate took account of the productivity effects of different training and transient loads, it ignored the relationship between productivity and experience. See reference 18.

Navy is currently planning to use these factors to support its attempt to achieve an efficient enlisted manpower mix with the ADSTAP system.

Estimating Relative Effectiveness on the Basis of Civilian Earnings

As noted above, the standard approach for estimating relative effectiveness is to obtain opinions from informed persons. There are a number of reasons to be skeptical about the accuracy of these estimates. Foremost among these are that the questions asked may have only little to do with relative effectiveness, and that the answers to the questions, however good the questions may be, are subject to errors of judgment on the part of the respondent. Survey responses, while useful for learning about opinions, are less than perfect instruments for obtaining factual information. Three of the four studies cited in the previous section seem particularly vulnerable to the complaint that every respondent interviewed was a senior enlisted person, who might be inclined to overestimate the relative effectiveness of senior enlisted personnel.

An alternative methodology is to use earnings in the civilian sector as a substitute measure of relative effectiveness. The underlying rationale for such an approach is that, in the absence of serious labor market imperfections, the amount of remuneration that employers pay to each employee ought to be closely related to the marginal product of that worker.

The Census Bureau reports civilian earnings by age, occupation, educational attainment, marital status, and other demographic characteristics. One approach would be simply to identify a civilian occupation that closely resembles each Navy rating, and use civilian pay, as a function of age or experience, in each of those occupations as the proxy for Navy marginal product. We reject the use of occupation-specific age-earnings profiles primarily because of the difficulty of finding many Navy ratings that have close civilian counterparts.

Civilian earnings data are useful, however, even if we ignore information about civilian occupations. One would expect a person's pay in any occupation to be determined by characteristics that reflect ability and motivation, such as educational attainment, aptitude scores, and previous experience. In fact, an abundance of empirical research into the determinants of civilian income supports this conjecture. It shows, generally, that income is directly related to age, educational attainment, and aptitude score, and is lower if an individual is from the South or has never been married.

In annex A, we report the results of a similar analysis for active duty Navy enlisted personnel. In this treatment, we regress enlisted paygrade (an integer between one and nine, inclusively) on a set of demographic characteristics. The purpose of this exercise is simply to support the use of personal characteristics as determinants of productivity in the Navy, rather than to use the results of the analysis as the basis for determining Navy productivity. We prefer to rely upon the civilian sector results because we suspect the connection between earnings and productivity to be much closer in the civilian economy than in the Navy. Moreover, it would beg the question of determining Navy pay, to base this determination upon Navy paygrade.

The central idea, then, is to determine relative effectiveness for each experience class within a given Navy rating as follows: first, estimate the relationship between earnings and a set of demographic characteristics for a population in the civilian sector that is similar to the Navy population; then, calculate the average values of those characteristics for the persons in each

electrician's mate (AE), boilerman (BT), air controlman (AC), and engineman (EN). The AE and BT occupations have been identified as "sick" ratings (i.e., the Navy perceives critical shortages of manpower to exist in these ratings) by the Bureau of Naval Personnel (Pers-5Z); the AC and EN ratings have been identified as "healthy." These four ratings have been partitioned into the nine enlisted paygrades or "rates," E-1 through E-9. The mean values of the predictor variables for these rate and rating categories are shown in tables D-1 through D-3.

TABLE D-1
MEAN AGE OF NAVY ENLISTED PERSONNEL
BY PAYGRADE, FOR FOUR RATINGS,
AS OF 30 JUNE 1973

Paygrade	AE	BT	AC	EN	All Navy enlisted
E-1	20.4	19.7	19.5	19.8	19.3
E-2	19.8	20.0	20.1	20.0	20.0
E-3	21.3	21.1	21.3	21.2	21.7
E-4	22.6	22.6	22.4	23.1	22.9
E-5	25.7	27.2	25.2	26.9	26.5
E-6	33.4	33.5	34.0	33.6	32.7
E-7	37.0	36.3	37.4	37.0	36.7
E-8	38.7	37.2	40.3	39.1	38.8
E-9	<i>a</i>	40.2	45.2	42.8	41.9
Total	27.1	26.2	27.4	27.9	25.4

^aThere are no E-9s in this rating.

TABLE D-2
MEAN EDUCATION (YEARS OF SCHOOLING COMPLETED)
OF NAVY ENLISTED PERSONNEL, BY PAYGRADE, FOR
FOUR RATINGS, AS OF 30 JUNE 1973

Paygrade	AE	BT	AC	EN	All Navy enlisted
E-1	11.9	11.4	12.0	11.8	11.3
E-2	11.8	11.6	12.0	11.8	11.5
E-3	12.0	11.8	12.4	12.0	12.1
E-4	12.1	11.9	12.5	11.9	12.3
E-5	12.2	11.5	12.6	11.7	12.2
E-6	11.9	11.3	12.0	11.4	11.8
E-7	12.0	11.5	12.1	11.6	11.9
E-8	12.1	11.6	12.3	11.9	12.0
E-9	<i>a</i>	11.8	12.2	12.0	12.1
Total	12.1	11.6	12.3	11.7	12.0

^aThere are no E-9s in this rating.

TABLE D-3

**PROPORTION OF NAVY ENLISTED PERSONNEL MARRIED
OR WIDOWED, BY PAYGRADE, FOR FOUR RATINGS,
AS OF 30 JUNE 1973**

Paygrade	AE	BT	AC	EN	All Navy enlisted
E-1	.000	.097	.000	.044	.058
E-2	.145	.109	.094	.116	.094
E-3	.214	.168	.178	.171	.207
E-4	.392	.304	.334	.346	.330
E-5	.701	.653	.614	.659	.632
E-6	.889	.873	.906	.868	.862
E-7	.919	.908	.947	.887	.913
E-8	.942	.955	.939	.949	.939
E-9	<i>a</i>	.943	.909	.954	.944
Total	.611	.482	.577	.577	.428

^aThere are no E-9s in this rating.

We are now able to construct a relative effectiveness profile for the Navy enlisted force by paygrade. This is illustrated for the total Navy enlisted force in table D-4. We begin by calculating the predicted civilian weekly income of the average individual in each paygrade. This is done on the basis of the mean predictor characteristics in tables D-1 through D-3 and the regression equation (D-3). For example, the average E-1 in the Navy is 19.3 years old, has 11.3 years of education, and is married with a probability of .058 (columns (1), (3), and (5) of table D-4). Multiplying the values of these predictor characteristics by their respective coefficients from equation (D-3) gives the numbers in columns (2), (4), and (6) in table D-4. The sum of these three numbers plus the constant term from (D-3), 2.3157, is the predicted log of civilian income for paygrade E-1, 3.8775 (column (7) of table D-4). The anti-log of 3.8775 is \$48.30 (column (8) of table D-4), which is the predicted civilian weekly income of the average Navy man in paygrade E-1.

The same calculation for the other eight paygrades and the total enlisted force yield the remaining numbers in column (8) of table D-4. We then arbitrarily assign an effectiveness index of 100.0 to a person with a set of characteristics equal to the mean values for the total Navy enlisted force. That is individuals with a predicted income of \$77.01 (from the bottom row of column (8), table D-4) are assigned an effectiveness index of 100.0. The relative effectiveness index for each paygrade (column (9), table D-4) is then its predicted income divided by \$77.01, multiplied by 100. Table D-5 displays the relative effectiveness indexes produced by applying this method to four Navy enlisted ratings as well as to the total enlisted force.

Since the figures in table D-5 are index numbers, it is a simple matter to interpret them in percentage terms. For example, looking at the column for AEs we see that the average E-1 in this rating is 66.3 percent as effective as the average Navy man, while the average E-8 is more than twice as effective as the average Navy man.

On the face of it, table D-5 seems to suggest that the two problem ratings, AE and BT, are no more productive than the two healthy ratings, but are both more productive than most other

TABLE D-4

CONSTRUCTION OF RELATIVE EFFECTIVENESS INDEXES
FOR EACH PAYGRADE, TOTAL NAVY ENLISTED FORCE

Paygrade	Age adjustment		Education adjustment		Marriage adjustment		Total LINC (7)	Predicted civilian income (dollars) (8)	Relative effectiveness index (9)
	AGE (1)	LINC (2)	ED (3)	LINC (4)	MAR (5)	LINC (6)			
E-1	19.3	.7355	11.3	.7974	.058	.0289	3.8775	48.30	62.7
E-2	20.0	.7622	11.5	.8116	.094	.0469	3.9364	51.23	66.5
E-3	21.7	.8270	12.1	.8539	.207	.1032	4.0998	60.33	78.3
E-4	22.9	.8727	12.3	.8680	.330	.1646	4.2210	68.10	88.4
E-5	26.5	1.0099	12.2	.8610	.632	.3152	4.5018	90.18	117.1
E-6	32.7	1.2462	11.8	.8327	.862	.4300	4.8246	124.54	161.7
E-7	36.7	1.3986	11.9	.8398	.913	.4554	5.0095	149.83	194.6
E-8	38.8	1.4787	12.0	.8468	.939	.4684	5.1096	165.60	215.0
E-9	41.9	1.5625	12.1	.8539	.944	.4709	5.2030	181.82	236.1
Total	25.4	.9680	12.0	.8468	.428	.2135	4.3340	77.01	100.0

Sources: Col. 1: Table D-1.
Col. 2: [Col. 1] x .03811.
Col. 3: Table D-2.
Col. 4: [Col. 3] x .07057.
Col. 5: Table D-3.

Col. 6: [Col. 5] x .49879.
Col. 7: [Col. 2] + [Col. 4] + [Col. 6] + 2.3157.
Col. 8: Anti-log of [Col. 7].
Col. 9: ([Col. 8] ÷ \$77.01) x 100.

TABLE D-5

RELATIVE EFFECTIVENESS INDEXES FOR SELECTED
NAVY ENLISTED RATINGS BY PAYGRADE

Paygrade	AE	BT	AC	EN	All Navy enlisted
E-1	66.3	65.4	64.5	65.8	62.7
E-2	69.2	67.5	69.2	68.7	66.5
E-3	76.9	73.5	77.7	75.0	78.3
E-4	88.9	83.9	88.2	87.7	88.4
E-5	117.6	115.7	113.6	116.3	117.1
E-6	169.5	161.8	176.2	163.2	161.7
E-7	198.8	185.8	206.1	191.1	194.6
E-8	216.1	198.3	232.6	217.1	215.0
E-9	^a	224.1	274.2	252.3	236.1
Total	117.7	102.0	118.7	116.0	100.0

^aThere are no E-9s in this rating.

ratings. Both of these conclusions may be incorrect. It is likely that the overall indexes for AE and BT turn out to be no higher than for AC and EN largely because the Navy is trying to solve its problems in the former two ratings by promoting relatively inexperienced persons more rapidly. Hence, the billets in these ratings happen to be occupied by persons who are less qualified than is customary. The primary cause of the fact that the overall indexes for the four selected ratings are higher than 100.0 is likely to be that many young and unmarried Navy enlisted personnel are "undesigned" (i.e., not assigned to a rating).

Conclusion

We have attempted to explain the importance of having accurate estimates of relative effectiveness for each category of Navy personnel, to review previous attempts to make such estimates, and to demonstrate a methodology that we believe to be more promising than the standard alternative technique, which relies on opinion surveys.

A comparison of our results with those of earlier studies reveals that the opinion surveys tend to produce somewhat more steeply sloping productivity profiles than the profile we have produced on the basis of civilian earnings. The B-K Dynamics study (reference 17), for example, estimated that an enlisted career supervisor (E-7s through E-9s) is roughly six to 14 times more effective than a first-term apprentice (E-1s and E-2s),¹ while we observe that persons in the civilian sector with demographic characteristics like those of the "average" E-9 in the Navy earn less than four times that of persons who have characteristics like the average E-1.

We wish to emphasize that these estimates stand to be greatly refined. The three predictor variables we have used explain only 28.5 percent of the variance in civilian wage/salary income. We suspect that by measuring such additional characteristics as aptitude scores, work experience, training, and demographic characteristics of parents, the basic methodology of this paper can be made to measure productivity more accurately than we have been able to.

¹See table A-2.

APPENDIX E

CALCULATION OF CAREERIST PREMIUMS

This appendix presents calculations of the careerist premium for 36 Navy ratings, including the seven presented in table 7 of the text. Ratings were chosen for inclusion in this appendix on several grounds. They are all ratings with a significant population size, no six-year obligors, an A School, and data available from the Navy Billet Cost Model (BCM).

We begin by detailing the actual calculations. We then present the calculated careerist premiums themselves and note and explain some apparently anomalous numbers. Finally we conclude by expanding the discussion in the text concerning the use and application of these numbers.

Data and Calculation

Recall equation (6) in the text:

$$\frac{\overline{MP}_C}{\overline{MP}_f} = \frac{\overline{E}_C + B}{\overline{E}_f + T} \quad (E-1)$$

We argued that the right-hand side of this equation could be estimated with a reasonable degree of confidence while the left-hand side could not. If the right-hand side, alone, were estimated, it would represent how much more productive a careerist must be to justify paying a bonus associated with a given B. The term $\frac{\overline{MP}_C}{\overline{MP}_f}$, however, reflects not only the relative productivity of individuals at different points in a career, but also the fact that a new careerist will yield a larger number of expected years of service than will a new first-termer. Thus we have defined the careerist premium, CP, in percentage terms, as follows:

$$CP = \left(\frac{\overline{TC}_C}{\overline{TC}_f} - 1 \right) \times 100 \quad (E-2)$$

The term \overline{TC}_C is simply equal to the quantity $\overline{E}_C + B$ in equation (E-1) but the term \overline{TC}_f is equal to the quantity $\overline{E}_f + T$, adjusted for the fact that a *succession* of first-termers is necessary to replace the expected years of service of a new careerist.

The actual calculation of CP proceeded as follows. The term $\overline{TC}_C (= \overline{E}_C + B)$ was calculated as described in appendix A. We have calculated CP for four values of B: that B associated with no bonus and those values of B associated with bonuses of \$2,000, \$6,000, and \$10,000. These are, approximately, bonuses of SRB multiple 0, 1, 3, and 5, respectively. The B associated with each bonus was calculated by use of equation (4), reproduced here:

$$B = \text{Bonus} (1 + 1/\sigma) \quad (E-3)$$

where σ is the fractional increase in reenlistments generated by the given bonus. The value of σ is, in turn, based on an assumed pay elasticity of 3.0, and calculated using the constant elasticity formula shown on page A-2. The calculation of B is summarized in table E-1.

The term \overline{TC}_f , which is the present value of the cost of the succession of first-termers necessary to "replace" a careerist, was calculated in three steps. First, the cost of one first-termer,

TABLE E-1
CALCULATION FOR B FOR
SEVERAL BONUS SIZES

Bonus size	Percentage increase in reenlistment rate (percent)	σ	B (= cost per additional reenlistment)
\$10,000 (\approx SRB 5)	104	1.04	\$19,615
\$6,000 (\approx SRB 3)	56	.56	16,714
\$2,000 (\approx SRB 1)	17.5	.175	13,428
\$0 (= SRB 0)	0	0	0

\overline{tc}_f , was calculated exactly the same as the term $\overline{E}_f + T$ as described in appendix A. Second, \overline{tc}_f was then multiplied by the sum of the probabilities that a careerist in the given rating would still be in the Navy at the beginning of the 5th, 9th, 13th, and 17th years. Symbolically (ignoring discounting):

$$\overline{TC}_f' = \overline{tc}_f \cdot \sum_{i=1}^4 C_{4i+1}^5 \quad (E-4)$$

where \overline{tc}_f is defined as before and C_{4i+1}^5 is the probability that a careerist is still in the Navy at the beginning of year $4i+1$ ($=5, 9, 13, 17$). We set C_5^5 equal to 1.0 by definition. Third, \overline{TC}_f' was then adjusted to reflect the fact that four first-termers (or fractional first-termers) might still yield a different expected number of years of service than one careerist because of different loss rates between the beginning and end of each four-year term and the fact that a first-terminer, because of training, is "lost" for all or part of the first year of service. That is, this third adjustment changes equation (E-4) to read:

$$\overline{TC}_f = k \cdot \overline{tc}_f \cdot \sum_{i=1}^4 C_{4i+1}^5 = k \cdot \overline{TC}_f' \quad (E-5)$$

The term k reflects this latter adjustment and is calculated as

$$k = \frac{\sum_{i=5}^{20} C_i^5}{\sum_{i=1}^4 C_{4i+1}^5 \cdot \left(\sum_{i=1}^4 C_i^1 \right)} \quad (E-6)$$

where C_i^5 is the probability that a careerist is still in the Navy at the beginning of year i and C_i^1 is the probability that a first-terminer is in the Navy at the beginning of year i ($C_i^1 = 1.0$ by definition).

The individual terms in \overline{TC}_f and \overline{TC}_c were all discounted back to the beginning of year 1 using discount rates of 4 and 10 percent. The ratio $\frac{\overline{TC}_c}{\overline{TC}_f}$ was calculated and converted to percentage terms as described in equation (E-2).

The annex to this appendix demonstrates the calculation of the careerist premium for the AC rating. This annex and the output of the Navy's Billet Cost Model (BCM) for any rating would enable the reader to reproduce our results.¹

Results

Table E-2 lists our 36 ratings alphabetically and their respective careerist premiums for four bonus sizes and two discount rates. Table E-3 lists these same ratings in ascending order of their careerist premium assuming a \$10,000 bonus and a 10 percent discount rate. Table E-3 also includes our estimate of "marginal training costs" and the FY 1975 SRB multiple assigned each rating.

Recall first that the careerist premium is simply a measure of the relative costs of careerists and first-terminers. Thus row 1 of table E-2 says that an AB careerist, in the absence of any bonus, costs 31 percent more than an equivalent (in terms of expected years of service) succession of first-terminers. At a bonus of \$10,000, careerists cost 53 percent more. Thus for AB careerists to be a good "buy" with a \$10,000 bonus, they must be *at least* 53 percent more productive than AB first-terminers.

The occasional zero that appears in tables E-2 and E-3 are for ratings where the ratio $\frac{\overline{TC}_c}{\overline{TC}_f}$ is less than one. In these ratings careerists are absolutely cheaper than first-terminers and they should be preferred to first-terminers unless they are *less* productive.

Note, in table E-2, that while the discount rate assumption affects the size of the careerist premium, it generally does not affect the relative ranking of these ratings. Note also that there is not a great change in the careerist premium due to differences in bonus size. This is a result of the fact, illustrated in table E-1, that there is less relative difference between the Bs associated with various bonuses, than between the bonuses themselves.

Turning to table E-3, note that generally speaking, ratings with high first-term training costs are also ratings with low careerist premiums. That is, they are ratings where careerists are a "good buy" because first-terminers are relatively expensive.

¹For a description of the BCM and its output see references 5 and 6.

TABLE E-2

CAREERIST PREMIUMS FOR SELECTED RATINGS

Rating	Discount rate = 4 percent				Discount rate = 10 percent			
	0	\$2,000	\$6,000	\$10,000	0	\$2,000	\$6,000	\$10,000
AB	31%	47%	50%	53%	29%	51%	58%	63%
AC	13	28	32	35	11	33	38	43
AD	64	81	85	88	59	84	90	96
AE	40	55	59	62	39	62	68	73
AG	16	29	33	35	22	44	49	54
AK	54	72	76	79	51	77	84	90
AM	43	58	61	65	37	60	65	70
AO	47	62	66	69	41	65	70	75
AS	39	53	57	60	35	59	65	70
AW	22	32	34	36	18	33	37	41
BT	20	35	39	42	23	46	52	58
CS	38	54	57	60	31	55	60	65
CTA	43	56	60	63	37	59	65	70
CTI	0	0	1	2	0	0	1	2
CTO	34	47	50	53	27	48	53	56
CTR	21	32	34	37	19	36	40	44
DK	23	35	39	42	18	33	38	43
DT	30	48	52	55	23	48	55	60
EN	54	72	76	80	52	80	86	93
GMT	28	41	44	47	21	42	47	53
HM	0	0	0	0	0	0	0	3
HT	51	65	68	71	51	75	81	86
MR	46	62	66	69	47	72	78	83
OS	46	61	65	68	43	67	73	78
OT	50	65	68	71	46	70	76	81
PC	45	62	67	70	39	65	73	78
PH	41	54	59	66	38	60	66	71
PN	30	43	46	50	24	46	50	55
PR	22	34	38	39	19	35	39	44
QM	41	58	62	65	34	60	65	70
RM	22	35	38	40	15	36	40	45
SK	42	58	60	64	35	60	64	70
SM	40	56	60	62	31	56	62	67
TD	24	39	43	50	22	44	50	54
TM	9	19	22	26	6	23	26	30
YN	46	61	65	68	39	64	68	72

TABLE E-3

CAREERIST PREMIUM, FY 1975 SRB MULTIPLE, AND TRAINING COSTS FOR SELECTED RATINGS

Rating	Careerist premium: \$10,000 bonus, 4 percent discount rate	FY 1975 SRB multiple	Training costs (dollars)
HM	0	0	10,968
CTI	2	1	16,492
TM	25	5	12,009
AC	35	3	10,842
AG	35	3	8,269
AW	36	5	12,400
CTR	37	0	10,388
PR	40	1	9,981
RM	41	2	9,491
DK	42	1	6,380
BT	42	5	5,950
TD	46	1	10,482
GMT	47	5	9,036
PN	50	2	6,464
CTO	53	4	9,797
AB	53	0	6,730
DT	55	1	12,343
AS	60	0	7,295
CS	60	1	5,490
PH	62	0	9,066
AE	62	4	7,578
CTA	63	1	6,571
SM	63	4	5,374
SK	64	2	5,625
AM	65	2	6,861
QM	65	4	5,139
OS	68	2	8,868
YN	68	2	3,673
AO	69	3	7,475
MR	69	4	6,420
PC	70	1	5,262
HT	71	5	7,858
OT	71	2	7,051
AK	79	0	6,616
EN	80	3	5,936
AD	88	1	6,541

Source: Careerist premium taken from table E-2; SRB multiples taken from the Bureau of Naval Personnel.

Uses and Applications

Before discussing the possible uses of these careerist premiums, we should issue several warnings. First, these numbers are subject to all the biases summarized in table 6 in the text. Any error leading to a bias in our estimates of the reenlistment premium will lead to a bias in the opposite direction in our estimates of these careerist premiums. Thus, these numbers are probably all biased downward. Second, and perhaps more importantly, these numbers are based on continuation rates currently used in the BCM. These rates, in turn, are based on experience in the early 1960s. There is no reason to expect these rates to generally reflect current experience. We have used them here because of their ready availability.

We have discussed the use of these careerist premiums in the text so we will merely summarize them here. In the absence of any other information, ratings with low careerist premiums ought to receive high bonuses. Other criteria that would be useful in determining bonus size for each rating are (1) the relative productivity of careerists and first-termers, and (2) the relative mix of careerists and first-termers in each rating.¹ (We have argued, of course, that criterion (2) will affect (1).) The Navy does not have any objective information concerning relative productivity. Thus the principal reason the careerist premiums in table E-3 bear virtually no relationship to the FY 1975 SRB multiples assigned each rating must be due to the second criterion, or, more exactly, career manning deficiencies.² This indicates to us that the Navy is doing precisely what we have argued they should not. That is, bonuses are apparently being assigned largely on the basis of career manning deficiencies with little or no regard to the relative costs of careerists and first-termers.

¹We have ignored a third criterion throughout this study. This criterion is the productivity or value of careerists in one rating compared to the value of careerists in some other rating. See footnote 1, page 21.

²This is not entirely certain, however, since the EN rating is drawing a multiple 3 bonus despite the fact that first-termers are relatively cheap (as evidenced by the low training costs and the high careerist premium) *and* there exists no career manning deficiency in this rating.

ANNEX A

CALCULATION OF THE CAREERIST PREMIUM FOR THE AC RATING

Calculation of the careerist premium requires the calculation of two terms, \overline{TC}_c and \overline{TC}_f (see equation E-2)). The term \overline{TC}_c is the sum $\overline{E}_c + B$ which was used to calculate the reenlistment premiums presented in the text. Table E-1 summarizes the calculation of B while table E-4 summarizes the calculation of \overline{E}_c and \overline{TC}_c .

TABLE E-4
CALCULATION OF \overline{TC}_c FOR THE AC RATING
(*r = 4 percent*)

Year	Continuation rate, C_i	Cumulative continuation rate, C_i^5	Maintenance costs, E_i	Expected maintenance costs, \overline{E}_i
5	.838	1.000	\$15,237	\$15,237
6	.838	.838	11,043	9,254
7	.903	.702	11,446	8,035
8	.953	.634	11,446	7,257
9	.921	.604	11,713	7,075
10	.925	.557	11,713	6,524
11	.920	.515	12,090	6,226
12	.975	.474	13,019	6,171
13	.980	.462	13,419	6,200
14	.971	.453	13,419	6,079
15	.968	.439	13,682	6,006
16	.999	.425	14,371	6,108
17	.981	.425	15,075	6,407
18	.992	.417	15,075	6,286
19	.963	.414	15,788	6,536
20	.746	.398	16,817	6,693
Present value of expected maintenance costs, $PV(\overline{E}_i)$				\$89,606
Present value of retirement costs, $PV(Ret)$				18,998
$\overline{E}_c = PV(\overline{E}_i) + PV(Ret)$				108,604
B (for \$10,000 bonus)				19,615
\overline{TC}_c				<u>\$128,219</u>

The figures in the first and third columns of table E-4, the c_i and E_i , are taken from the BCM output for the AC rating. The c_i are the continuation rates which were reproduced in table A-1 above, while the E_i are calculated by subtracting the items (in the BCM) labeled "Reenlistment and Settlement Cost" and "Retirement Contribution" from the item labeled "Total Cost." The second column, C_i^5 , is calculated from the c_i by the formula:

$$C_i^5 = \prod_{j=5}^i C_j - 1$$

where $C_4 = 1.0$ by definition. The fourth column, E_i , is the product of the second and third columns. That is, $\bar{E}_i = E_i \cdot C_i^5$.

The calculation of \overline{TC}_C is then done in three steps. First, the present value of the \bar{E}_i (at the beginning of year 5), $PV(\bar{E}_i)$ is calculated by discounting, from the middle of each year, the values of \bar{E}_i in column 4 back to the beginning of year 5. That is,

$$PV(\bar{E}_i) = \sum_{i=5}^{20} \left[\bar{E}_i / (1+r)^{i-5+1/2} \right]$$

In this case, r , the discount rate, was set at .04 and $PV(\bar{E}_i)$ equals \$89,606, which is shown at the bottom of table E-4. To $PV(\bar{E}_i)$ we then add the cost of retirement, $PV(\text{RET})$, to obtain the sum \bar{E}_C . (The calculation of $PV(\text{RET})$ is not shown in table E-4. It is calculated as the present value, at the beginning of year 5, of an annuity paying 50 percent of E-7 base pay for 34 years after the end of year 20. Base pay for an E-7 is the FY 1974 figure, \$792.90 per month, so the present value of the annuity is \$47,710. This figure is then multiplied by C_{20}^5 (.398), the probability that an AC will reach retirement, to obtain the \$18,998 shown in table E-4.) We finally add B (\$19,615 for a \$10,000 bonus, from table E-1) to \bar{E}_C and obtain the sum, \overline{TC}_f , which is \$128,219 for an AC.

Table E-5 summarizes the calculation of \overline{TC}_f for the AC rating. The four columns of table E-5 are drawn from the same sources and calculated in the same way as the four columns of table E-4. The calculation of \overline{TC}_f then proceeds as follows. First \bar{E}_f is calculated as

$$\bar{E}_f = \frac{A \cdot \bar{E}_1}{(1+r)} + \sum_{i=2}^4 \left[\bar{E}_i / (1+r)^{i-1/2} \right]$$

In this case, r , the discount rate, was set at .04 and \bar{E}_f equals \$28,997, which is shown in table E-5. Since part of the first year is spent in school, only part of the first year costs (the fraction A) are counted as maintenance costs and included in \bar{E}_f . The remainder of first year costs (the fraction $1 - A$) are counted as training costs.

To \bar{E}_f we then add marginal training costs ($T = \$10,759$) to obtain tc_f which equals \$39,756 in this case. (The calculation of T is not shown in table E-5.) It is composed of two elements, the cost of providing training, and the cost of maintaining the trainee while he is in training. The latter is simply the product, $\bar{E}_1 \cdot (1 - A)$, or \$4,347 in this case. The cost of providing training is calculated from figures in the BCM. The item labeled "School Cost" in the BCM output equals \$7,336 for the AC rating and includes the cost of initial skill training as well as the cost of procurement and boot camp training. This latter item is \$1,201 (for all ratings) in the BCM. We subtract \$1,201 from \$7,336 to obtain the FY 1972 costs of initial skill training. This figure is

TABLE E-5
CALCULATION OF \overline{TC}_f FOR THE AC RATING
(r = 4 percent)

Year	Continuation rate, C_i	Cumulative continuation rate, C_i^1	Maintenance costs, E_i	Expected maintenance costs, \overline{E}_i
1	.984	1.000	\$7,418	\$7,418
2	.915	.984	4,449	7,330
3	.877	.900	11,336	10,202
4	.783	.790	14,358	11,343
Available operational time in first year, $A = 0.414$				
Present value of expected maintenance costs, \overline{E}_f				\$28,997
Marginal training costs, T				10,759
\overline{tc}_f				<u>\$39,756</u>
$TC_f' = \overline{tc}_f \cdot \sum_{i=1}^4 C_{4-i+1}^5$ (from equation (E-4))				<u>\$84,273</u>
$k = \frac{\sum_{i=5}^{20} C_i^5}{\sum_{i=1}^4 C_{4-i+1}^5 \left(\sum_{i=1}^4 C_i^1 \right)} = \frac{8.14}{7.23} = 1.126$				
$\overline{TC}_f = k \cdot \overline{TC}_f'$				<u>\$94,892</u>

then inflated by 10 percent to adjust these costs to FY 1974 figures and the result is \$6,749 (= (\$7,336 - \$1,201) x 1.1), which is the "average cost" of skill training in FY 1974. We then add \$1,801, which is our estimate of the cost of procurement and boot camp training in FY 1974, to \$6,749 to obtain \$8,550 which is our estimate of the average cost of providing training. This figure is then multiplied by 0.75 to obtain our estimate of the marginal cost of providing training, \$6,412 (= \$8,550 x .75). The sum of the marginal cost of providing training, \$6,412, and the cost of maintaining the trainee, \$4,347, is the marginal cost of training, \$10,759 (= T = \$6,412 + \$4,347), which is shown in table E-5.)

With this estimate of \overline{tc}_f , we then calculate \overline{TC}_f' , k , and finally \overline{TC}_f as described above in equations (E-4), (E-5), and (E-6). The result, \overline{TC}_f , is shown in the last line of table E-5 as \$94,892.

Given \overline{TC}_C (\$128,219, from table E-4) and \overline{TC}_f (\$94,892, from table E-5) we then calculate the careerist premium, CP, as described in equation (E-2). The ratio of \overline{TC}_C to \overline{TC}_f is 1.35, and thus 35 percent appears in tables E-2 and E-3 for the AC careerist premium associated with a bonus of \$10,000 and a discount rate of 4 percent.

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