Evaluating Retention and Accessions Cost Tradeoffs for Navy Enlisted Personnel

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Executive summary

It is costly for the Navy to change policies regarding reenlistment and accessions (R&A). This is true not only in terms of the spending needed to achieve desired results, but also in terms of the effects of policy changes on current and future readiness. In stable endstrength and economic environments, expenditures on R&A will tend to also be stable. External events that require the Navy to modify R&A policy will change relative expenditures in the current period. But this will also affect the downstream shape of the Navy's force in ways that could require additional modifications in the future.

N-814 asked CNA to begin development of a model of cost tradeoffs of R&A for enlisted personnel. The objective of the model would be to help the Navy determine an optimal mix of R&A for changing requirements and under various economic conditions, in both the short and the long run.

Using standard statistical techniques and 25 years of data from various Navy, DOD, and civilian sources, we developed a set of simulation models that project the effects of various R&A strategies on total, average, and marginal costs, as well as their effects on future distributions of senior and junior enlisted personnel. We made four models—one for all Navy enlisted personnel, one each for Machinist Mates (MM) and Operations Specialists (OS), and one in which we combine Electronics Technicians (ET) and Fire Control Technicians (FC).

We found that average reenlistment costs were nearly double that of accession costs. More important, the marginal cost of reenlistments was four times greater than marginal accession cost. While amounts varied by rating, this implies that, in general, reducing reenlistments relative to accessions could save the Navy substantial amounts of money. This strategy, however, results in measurable changes in the seniority distribution of personnel in ways that could diminish Navy readiness and necessitate future costly changes in R&A policy.

Comparing reenlistment and accession costs

Comparing reenlistment and accession costs is not straightforward. First, because of early attrition, the tradeoff between an accession and a retainee is not one to one. Second, the direct costs of accessions are: recruiter pay, trainee pay, and enlistment bonuses. The only direct cost for reenlistments is Selected Reenlistment Bonuses (SRBs), the average of which is lower than average accession costs.

However, a large indirect cost of reenlistment is higher wages for more senior people. Of course, the Navy receives a benefit from additional experience, but we find that the dollar value of additional output doesn't necessarily equal its dollar cost. The Navy needs to pay this higher cost just to get enough senior people, but the result is that the cost of reenlistments is higher than the cost of accessions.

Average R&A costs per person and per productive year

The average cost of an accession ranges from over $20,000 to $40,000 per accession, with the Navy-wide average nearly $25,500. Average reenlistment costs, which include both SRBs and seniority costs, are about $52,200.

The expected number of productive years differs for retainees and accessions. We estimate that an average retainee will provide around 6.9 productive years, while an accession will provide about 4.9 years. Nonetheless, reenlistment costs per productive year are still higher at about $7,600, compared with $5,200 for accessions.

Average vs. marginal costs

More important than the fact that *average* reenlistment costs are higher than average accession costs is that *marginal* reenlistment costs are higher than marginal accession costs. The one-price rule for SRBs causes this to happen. In order to change reenlistments, the Navy changes SRBs. The one-price rule means that, for personnel within a rating and reenlistment zone, if the SRB is changed for one, it must be changed for all.

A list of marginal reenlistment costs appears in a later section, but we cite an example from our simulation model here. While the average SRB for an MM was about $11,700, the marginal SRB cost per retainee was about $55,500 when the Navy needed to give a $430 increase in SRBs to all eligible MMs.

The effects of changing economic conditions

Changing economic conditions affect stay rates and attrition rates. The effects are small when moving from an economy with average (or normal) growth to one with high growth, but effects are large when moving from a normal to a slow growth economy.

For example, average attrition rates were 7.6 percent during normal growth periods and 7.9 percent in high growth periods—a small difference. Average attrition rates, however, were about 6.1 percent in slow growth periods, which is a substantial difference. These differences are even larger for some of the high-tech ratings.

Consequently, in a slow economy, the Navy can find it difficult to reduce reenlistments enough to maintain endstrength levels. Further, various potential strategies to reduce reenlistments can result in increasing the average seniority of the Navy's forces in following years, even well after the economy has returned to normal.

Recommendations

Reducing reenlistments to save money

Because the marginal costs of reenlistments are high relative to accessions, the Navy can usually save money by reducing reenlistments. This is true even if one does not accept our method for estimating seniority costs (and thus disregards them completely). At recent historical SRB rates, because of the one-price rule, marginal SRBs alone are higher than marginal accession costs.

In the current slow economy, the Navy is finding that it can reduce SRBs to zero for many ratings and still retain enough personnel to maintain adequate strength levels. Because of the nature of reenlistment elasticity modeling, our model doesn't consider the effects of fully eliminating the SRB reenlistment rates. But, when SRBs are dropped to zero, the marginal cost of SRB for *additional* reductions in reenlistment also become zero (because there is no such thing as a negative SRB). In that case, there is no longer a marginal cost advantage for reenlistments, and other factors will dominate.

Balancing savings with long-run effects in the shape of the force

Navy strategies to retain the correct number of people can have consequences on the distribution of junior and senior personnel, which can persist even after economic conditions return to normal. Our model assumes that the value of military experience is constant, regardless of the existing proportions of junior and senior personnel. However, economic theory suggests that the value of military experience will vary with these relative proportions.

Consequently, today's R&A decisions will influence future Navy readiness. We recommend that the Navy balance current dollar savings with future changes in the shape of the force.

Future research and development of the R&A cost model

The results of this study reflect a "model development" phase in this line of research. A second phase of research could explore the application of this model to a variety of scenarios and formulate resulting policy implications. We recommend two areas of research to improve the Navy's R&A strategies.

First, in our models, we assume the elasticity of reenlistment with respect to SRBs to be constant, but this is only correct for small changes in SRB. Additional research might develop statistical methods for estimating elasticities over big changes in SRB.

Second, the model assumes that benefits to military experience are accurate across ratings and constant over a wide range of junior-senior distributions. These estimates might be fairly accurate at the moment since the junior-senior ratio Navy-wide is currently about average at roughly 60:40; however, future research might employ additional methods that can estimate values of experience across a wide range of distributions.

Introduction[1]

Declining Navy endstrength requirements and rapidly changing national economic conditions mean that the Navy must respond quickly and accurately to varying reenlistment and accession needs. The problem is twofold. First, the Navy can mostly only "influence" reenlistment with incentives, which can sometimes lead to unexpected or problematic outcomes. Second, with limited resources, the Navy needs to make reenlistment and accession strategies that are cost effective, and so needs to accurately assess the cost implications of its reenlistment and accessions plans.

Historically, the Navy has preferred to respond to declining personnel requirements by focusing on accessions. Accessions are more easily changed than reenlistments, since it can only influence the number retained, while it has more physical control over the number it accesses. Also, it is generally thought that accessions are expensive, given the cost of the long training pipeline and recruiting costs.

However there are two important factors that determine the efficiency and effectiveness of a given strategy. First, the cost-effectiveness of a strategy is determined by the relationship between *marginal* costs, not average costs. Second, today's R&A decisions will influence the tomorrow's distribution of personnel, and these changes can persist.

We develop a model of reenlistment and accession strategies that considers the effects of changing strategies on: reenlistment and accession rates, the total, average, and marginal costs of reenlistments and accessions, and the current and future effects of these strategies on

1. The authors would like to acknowledge David Gregory and David Reese for their efforts in preparing the data for analysis, Martha Koopman, Diana Lien, and Jennie Wenger for their contributions to the development of our analytical methods, and Molly McIntosh for her input into the simulation model.

the distributions of junior and senior personnel. We model these for the entire Navy and for four selected ratings, including Machinists Mates, Operations Specialists, Electronics Technicians, and Fire Control Technicians, the last two placed into a category called Advanced Electronics.

Here's how the paper in laid out. In the next section we look at the literature on the various reenlistment models and their implications on Navy's strategies. That is followed by a discussion of how we modeled stay and accessions rates, and a simulation model we developed to allow us to estimate the effects of changing R&A strategies.

In the following section, we discuss each of the various costs of R&A, the data we use to estimate actual costs, and how costs are influenced by changes in R&A strategies. In the next section we run two scenarios to determine the effect of changes to R&A on total, average, and marginal costs, and on the current and future distributions of personnel. In the final section we conclude and make some recommendations regarding Navy's R&A strategies.

Literature

Much of what we do in this study follows from a 2003 CNA study [2] of reenlistment and accessions costs. The authors in [2] provide a cost-benefit analysis of reenlistment and accession policy to determine if the current (2003) rate of reenlistment was cost-effective. In the study, the authors compare the marginal costs and benefits to the Navy when reenlistments or accessions are increased.

Using a "steady state" reenlistment model and maximum likelihood regression technique, the authors find that the marginal cost of reenlistment was substantially higher than the marginal benefits, suggesting that the Navy could save by reducing reenlistments and increasing accessions.

Other studies of reenlistments and accessions are: [3] Goldberg, 2001 provided summaries of the various types of reenlistment models that had been used up to that time; [4] Gotz and McCall 1983, and [5] Mattock and Arkes 2007, developed dynamic modeling methods to evaluate the effects of retirement policy and the effects of long-term contracts on stay rates.

There are several methods for modeling the effects of civilian wages, or more precisely, the difference between military and civilian wages, on reenlistment. For specifically estimating the effects of pay of all forms on reenlistment, the most effective are the lifecycle models, known as the "Annualized Cost of Leaving" (ACOL)[3], [7], the Total Cost of Leaving (TCOL) [8], and [9] and the Dynamic Retention Model (DRM) [5] and [6]. They all use Logit and Probit regression methods to forecast a probability of staying, which most reenlistment models do. But these use the expected difference between *total* career military and civilian income, as well as the standard independent variables to estimate the effects of changing wages on reenlistment. In using the DRM, [5] and [6]explicitly model uncertainty that follows a permanent policy change, or the value of an implied option value of signing a contract and taking themselves off the private sector market.

The goal of our model is to make relatively accurate predictions of stay rates, from which we can estimate changes in costs that follow changes the stay rates. We use a modeling technique called the “Military-Civilian Wage Ratio” method [1]. While the lifecycle methods are useful for estimated pay effects, constructing the ACOL model would require years of data on all the components of pay for both military and civilian personnel, including bonuses, retirement, and non-pay benefits. Additionally these methods require making assumptions about personal discount rates.

The value of the wage ratio is in its simplicity of use and the accuracy with which it predicts stay and attrition rates.

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Model of reenlistment and accessions

The Navy uses an "access and grow" method to obtain senior enlisted personnel. We would model this system as a flow, with accessions filling the junior enlisted and reenlistments filling the more senior enlisted potential vacancies. More specifically, service members who are at the end of their obligated service either stay or leave. The number of vacancies created by the leavers must be filled by accessions; however, accessions fill junior—not senior—ranks and then rise to more senior levels.

Thus, the Navy must accurately time reenlistments and accessions to maintain endstrength and the distribution of junior and senior personnel. Endstrength in the next period is equal to endstrength in this period minus losses from attrition, minus end-of-obligated-service losses, plus accessions, which must make up for losses. The algorithm for this flow of requirements, end of obligated service, reenlistment, and accessions is:

$$ES_{t+1} = ES_t - \sum_{y=yos}^{19} L_{y,t} - \sum_{y=yos}^{19} (1-\alpha_{t,y}) EAOS_{t,y} + A_t \quad (1)$$

where

ES_t = endstrength at time *t*, which is typically set by means of a coordination of the Navy, DOD, and Congress

$L_{y,t}$ = expected attrite losses at each *yos* at *t*

$EAOS_{t,yos}$ = members who have reached the end of an enlistment contract and are at the end of obligated service at their current *yos* at the current time *t*

$0 < \alpha_{t,y} < 1$ = stay rates at each *yos* at the current time *t*—that is, they are proportions of service members at each *yos* who are at the end of their active obligation and that are retained; as we'll see, the Navy can influence these proportions with allocations of SRBs

A_t = accessions; the Navy sets accession requirements each year and reaches its accession goals through a combination of enlistment bonuses and recruiter productivity.

Approach

Using data from the Navy's Enlisted Master Files, the Navy's PRIDE database, the Navy's Office of Accessions Policy, the U.S. Current Population Survey (CPS), and the U.S. Bureau of Labor Statistics (BLS), we estimated reenlistment rates and accession rates, as well as total, average, and marginal costs of reenlistments and accessions. We developed a simulation model that will project (a) the effect of changing reenlistment and accessions on the total, average, and marginal costs and (b) the effect on the distribution of senior and junior enlisted personnel up to 10 years in the future. The model in equation 1 forms the basis for examining reenlistment and accessions in a simulation model that provides a means for us to analyze costs and cost tradeoffs.

How the simulation model works: reenlistment and accession parameters[2]

We begin with an original, what we call "steady state," distribution of personnel by years of service (YOS). These are simple calculations of the average proportions of personnel for YOS 1 to YOS 19 over the 1983–2007 period. We estimate the average number of accessions using the PRIDE data for 1983 to 2007, and this becomes the number of personnel in YOS 0. We calculate one steady-state distribution for

2. We would like to thank Dr. Molly F McIntosh for her helpful ideas to on building and improving this simulation model.

All-Enlisted, and one each for MM, OS, and Advanced Electronics. See table 1 for the All-Enlisted distribution. Tables for analogous distributions for select ratings are in appendix A.

Table 1. Steady state distribution of personnel by YOS: All-Enlisted[a]

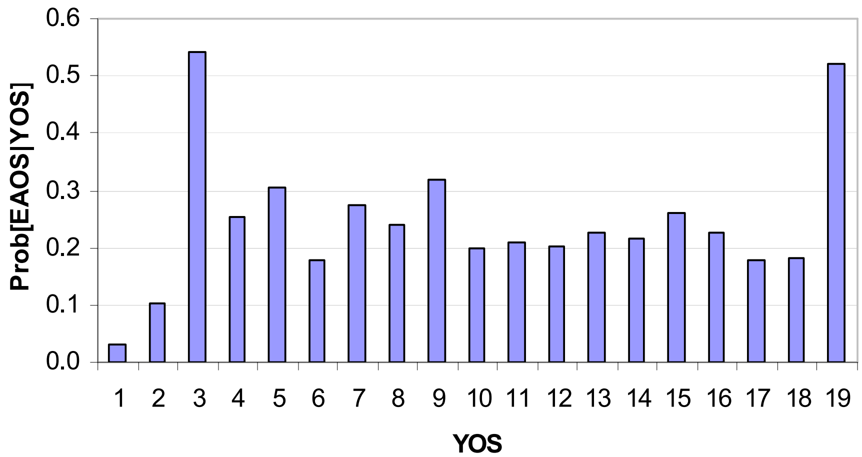
YOS	Proportion of personnel in YOS[b]
0 (accessions)	0.146
1	0.123
2	0.113
3	0.098
4	0.067
5	0.057
6	0.047
7	0.042
8	0.037
9	0.033
10	0.029
11	0.027
12	0.026
13	0.025
14	0.024
15	0.023
16	0.022
17	0.021
18	0.021
19	0.020

a. Source: Enlisted Master Records, 1983-2007.
b. Proportions may not sum due to rounding.

Next, we estimate the probability that each person in a given YOS will be at the end of the enlistment contract, more commonly referred to as the "end of active obligated service" (EAOS). Since the data do not reveal a correlation between this probability and national economic conditions or changes in the Navy's endstrength state, we use simple proportions of each YOS that are EAOS in the data.

Figure 1 shows the proportions of service members at each YOS that are at the end of their active obligated service. As expected, very few are EAOS before YOS 3, but more than half of those in YOS 3 are EAOS. Almost 20 to 30 percent of service members at all YOS 4 to 18 are EAOS, and over 50 percent of those YOS 19 and eligible for retirement that year are EAOS. Tables with proportions for select ratings are provided in appendix A.

Figure 1. Probability that service member is at end of enlistment contract, by YOS



Stay rates

In equation 1, $\alpha(yos)$ are the proportions of those who are EAOS who decide to stay. These so-called stay rates are what the Navy tries to control with selective reenlistment bonuses (SRBs). Previous studies have shown that this probability is a function of economic conditions and the Navy's endstrength state. It is also a function of the service member's expectations for civilian wages and the SRB offer made by the Navy.

Following this literature, we use LOGIT regression modeling to estimate these probabilities. Equation 2 describes the LOGIT model:

$$\Pi_{1y} = \beta_0 + \beta_1 EC + \beta_2\ YOS + \beta_3\ SRB + \beta_4 TECH + \beta_5\ CIVWAGE + \varpi \quad (2)$$

where

Π_{1y} = 1 if the service member stays
= 0 otherwise

EC = a set of indicator variables that describe the economic condition in the fiscal year as measured by GDP growth[a]: EC = 2 if GDP growth > 4 percent, EC = 1 if GDP growth is between 2 and 4, and EC = 0 if GDP growth < 2 percent

YOS = the year of service.

SRB = the dollar amount the service member is eligible for at the time of his or her decision

TECH = a set of indicator variables for high-tech, medium-tech, and low-tech ratings; these rankings came from an earlier study

CIVWAGE = our estimate of the wage each service member could expect for given rating and YOS

β_0 *through* β_5 = regression coefficients of the LOGIT model

w = an error term.

a. We looked at several measures of national economic conditions: GDP growth, unemployment rates, and a combination of both. We found that retention rates were more sensitive to GDP growth and that this indicator provided good variation across the years of data without overcomplicating the analysis.

We collect the estimates of Π_{1y} from this model at each *YOS* and use them to predict from one year to the next the number of service members who, at the end of contract, stayed in the service.

The estimated stay rates are the sum of the forecasted probabilities times the number of service members who are at risk (i.e., those who are at the end of their obligated service or are eligible for retirement) to get the number of service members the Navy can expect to stay given current policies.

Civilian wages estimation[3]

We use estimates of what service members would expect to earn in the private sector for two parts in our models. First, following much of the literature on military reenlistments, we estimate the effects of expected civilian wages on stay rates, in the model just described.

Second, in the calculations of seniority costs, we follow [2] and assume that the value of experience in the Navy is comparable to the value of experience to civilian employers. We use civilian pay increases over years of experience as a proxy for the value of increased productivity.

We use data from the March supplement to the CPS to obtain information on civilian wages from 1983 to 2008. We include only full-time, full-year workers and focus on enlisted-equivalent civilians (those who have reached 19 years of age and have at least a high school diploma but not a Bachelor's degree).

Following [15], we group our civilian occupations into three levels of technical expertise required—high, medium, and low tech—including only occupations that have equivalent Navy ratings. This causes us to exclude a portion of our sample, but it allows us to have differential effects of experience for the different levels of technical expertise. We ultimately place all the ratings into one of the three tech categories, based primarily on the length of its training pipeline.

Age is our proxy for civilian experience, but it is not a perfect substitute, so we expand our age group beyond 38 (when a typical enlistee is reaching retirement) and include civilians up to age 55. We create age groups roughly equivalent to the enlisted "zones." For example, in the military, zone A enlistees have between 0 and 6 years of service, and our civilian-equivalent age group is full-time workers age 19 to 25.

With the CPS data, we create a wage model to calculate the effects of demographic variables on earnings. We use log of real wages (2008

3. We would like to thank Michael Moskowitz for his excellent work compiling the CPS data and modeling the civilian wage equations.

dollars) as the dependent variable and include gender, race, age (as a proxy for experience), education, children, and year dummies.

Our model for estimating civilian wages in the wage index follows:

$$W_{Ct} = b_0 + b_1 Occ_t + b_2 Age_t + b_3 Sex + b_4 Race + b_5 Mar_t + b_6 Edu_t + b_7 Yr_t + b_8 Unemp_t + b_9 \Delta GDP_t) + u_t, \quad (3)$$

where

W_{Ct} = our estimate of expected civilian wage: $W_C(Occ_t, Age_t, Sex, Race, Mar, Edu_t, Yr_t, Unemp_t, \Delta GDP_t)$

Occ_t = three 1/0 indicators for high-, medium-, low-tech rating and matched civilian occupation

Age_t = four 1/0 indicators for age-group categories that are roughly matched to Navy reenlistment zones (age categories are: 19–24, 25–28, 29–32, and 33+)

Sex = 1/0 indicator for male or female

$Race$ = 1/0 indicator for white or non-white

Mar_t = 1/0 indicator for married or not married at t

Edu = 1/0 indicator for high school grad or some college, including AA or AS at time of enlistment

Yr_t = 25 1/0 indicators for FY 1983–2008

$Unemp_t$ = continuous variable for the U.S. unemployment rate

ΔGDP_t = percentage change in real GDP from the previous FY to the current

Our objective is to estimate an expected civilian wage for each service member that is based on his/her rating, demographics, and U.S. economic conditions. Results are in appendix B.

We will use the estimated wages in the reenlistment model as part of the military and civilian wage difference index, which will look like this:

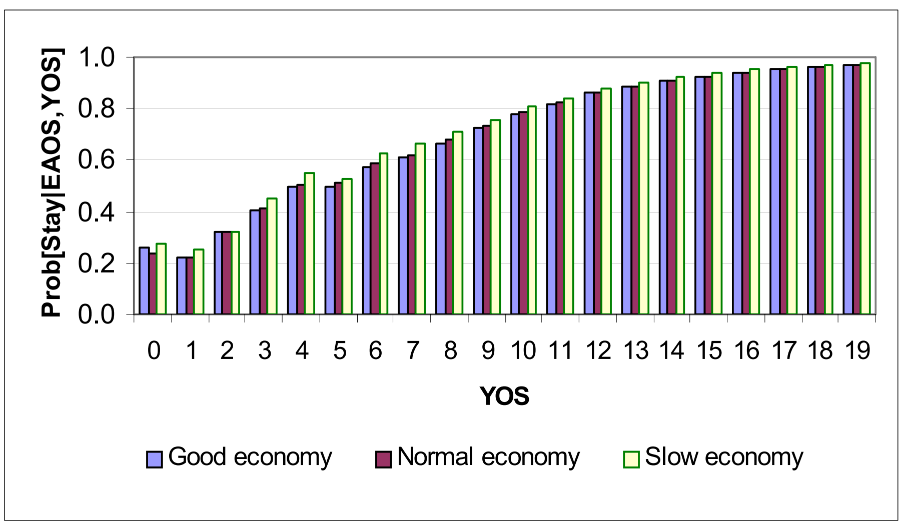
$$W_{It} = 1 - W_{Mt}/W_{Ct} \quad (4)$$

This index is used in the stay model presented earlier. Actual estimates of civilian wages are used in calculations of seniority costs.

Stay rate estimates

Estimates of stay rates for each of three economic conditions are charted on figure 2. Economic conditions have some, albeit small, effects on the probability of staying. The strongest effects are at YOS 3 through 6, which are zone A reenlistments. The tables for the stay rates for All-Enlisted and for select ratings are shown in appendix A.

Figure 2. Stay rate is probability that service members stay given that they are at the end of their service contract, for given YOS and economic conditions—All-Enlisted



Attrition

L_t from equation 1 is the attrition rate. Empirically, it is defined as the proportion who leave the service before their contract is finished, or technically, before their EAOS. We define it as the probability that a service member leaves the service given that he or she is *not* EAOS, for each YOS.

We find that attrition rates tend to rise and fall with good and bad economic conditions, and also tend to vary by YOS. Thus, we think of it as the probability of leaving, given that the service member is *not* at the end of his or her enlistment contract. We express this mathematically as:

$$(1 - Prob(Stay|not\ EAOS,\ YOS)) \tag{5}$$

For purposes of our cost estimates, we estimate the inverse of the attrition rates (i.e., the *Prob(Stay|not EAOS, YOS))* in the following LOGIT model:

$$\Pi_{2y} = \gamma_0 + \gamma_1 EC + \gamma_2\ YOS + \upsilon, \tag{6}$$

where

Π_{2y} = 1 if the service member stays
= 0 otherwise

EC = the economic condition in the FY as measured by GDP growth, described earlier

YOS = the year of service

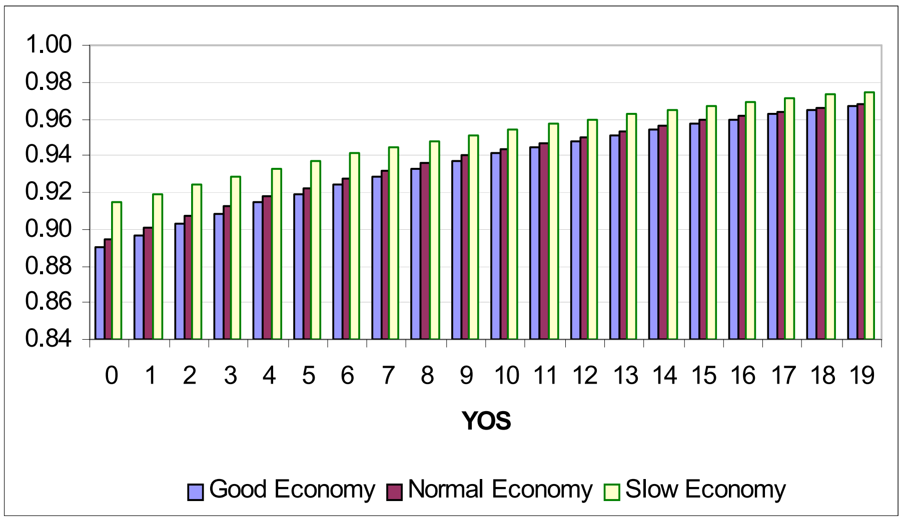
γ_0 through γ_2 = coefficients of the LOGIT regression model

υ = an error term.

We collect the estimates of Π_{2y} from this model at each YOS and use them to predict from one year to the next the number of service members who are *not* at the end of contract, who stay in the service.

We find that they are also influenced by economic conditions. In figure 3, we chart probabilities of stay for service members who are not at the end of their active obligation. The strongest effect occurs during slow economic conditions, when economic growth is well below average.

Figure 3. Probability that service member stays when he or she is not at EAOS (equivalent to one minus the attrition rate)



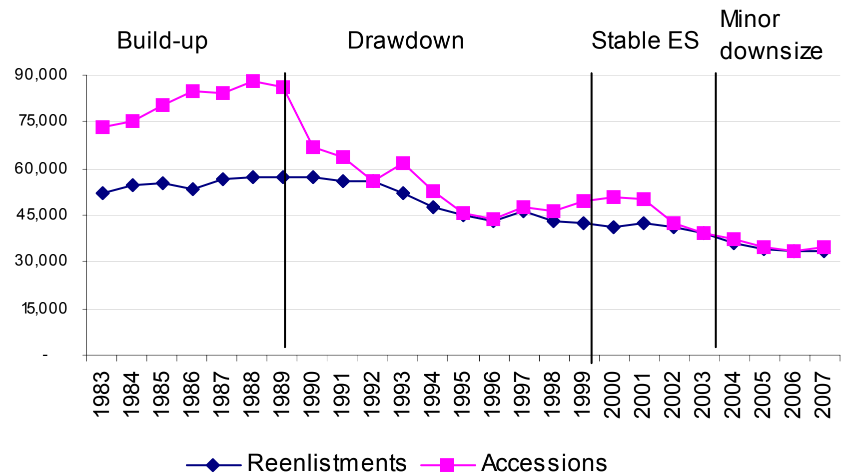
As we did with the other probabilities, we collect these probabilities, by YOS and by economic conditions, as described by the three economic indicators described previously.

Accessions and reenlistments over time

Accessions

We estimate Navy accessions with PRIDE data. In figure 4, we chart the number of Navy accessions from 1983 to 2008. We see that accessions rose during the Navy's buildup period of the 1980s, from around 73,000 to over 86,000. Accessions declined dramatically during the first half of the Navy's drawdown period of the 1990s, falling to about 45,000 in 1996. Accessions then stabilized, even rose a little to over 50,000 in the last half of the period, but have fallen for most of this decade, until they were about 35,000 in 2007.

Figure 4. Accessions from PRIDE data; reenlistments from EMR (1983–2007 All-Enlisted



Reenlistments

Reenlistments followed a trajectory over time similar to that of accessions, though the changes have not been nearly as dramatic. In the 1980s, accessions were roughly 40 percent higher than reenlistments, ranging from around 73,000 to 86,000, compared with reenlistments of around 52,000 in 1983 and 57,000 in 1989. In the 1990s, accessions dropped dramatically, to nearly half what they were in 1989. Reenlistments fell too, but only by about 25 percent, to around 43,000 by 1996.

Throughout the 1990s, accessions fell to the level of reenlistments. The reason most commonly cited for the reverse in the relative accession and reenlistment numbers was for the Navy to "keep faith" with its career service members. It resulted in the Navy making incentive payments to induce career service members to leave the service.

Accessions rose a little in the late 1990s, while reenlistments stabilized. Then, in the early 2000s, both reenlistment and accessions fell again to their 2007 levels of 33,000 and 35,000, respectively.

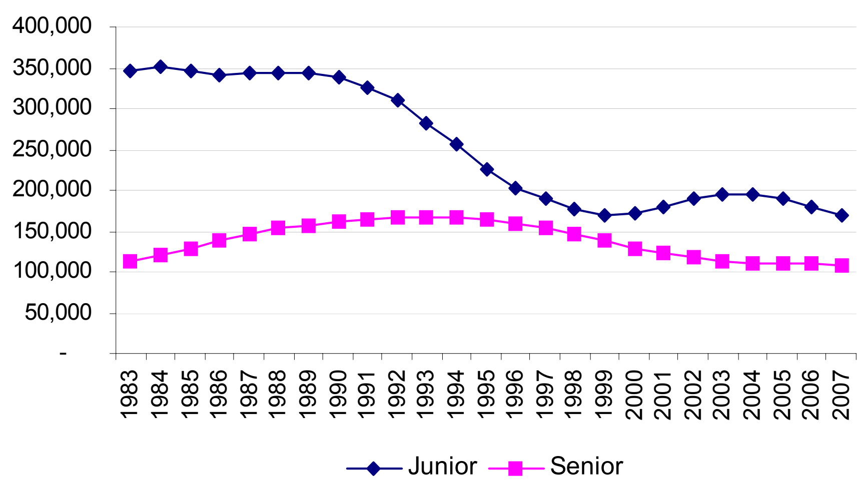
Reenlistment and accession (R&A) tradeoffs

Distribution of junior and senior personnel

One tradeoff the Navy made for reducing accessions relative to reenlistments was to end up with a more senior force. This has its own costs, in higher average wages, for one thing. But also, since the Navy employs an access-and-grow method of attaining a trained and experienced force, reduced accessions today implies a smaller pool from which to obtain senior service members tomorrow.

Figure 5 shows the distribution of personnel by seniority. Here we define junior enlisted as those YOS 0–5 and senior as YOS 6+. As we saw in figure 4, the accession rate fell below reenlistment rates. This resulted in a dramatically shrinking number of junior personnel, compared with the number of senior personnel.

Figure 5. Distribution of senior and junior enlisted from 1983 to 2007



The number of senior enlisted actually rose in the early days of the drawdown until about 1994, and was followed by a relatively small and continuous decline in the number of senior personnel from then until 2007. One result was that, by the late 1990s, nearly half of the force were senior personnel. Consequently, even when endstrength requirements were still falling or stabilizing in the late 1990s and early 2000s, accessions needed to be raised and reenlistments lowered in order to replenish the junior force.

Dynamic model of R&A

What makes a model dynamic is that today's decisions affect tomorrow's costs. So, in the R&A scenario, if the Navy over-retains today (because reenlistments are cheap, for example), the YOS distribution will change tomorrow, and this will change the relative costs. Or, when something such as the economy changes, R&A costs change, resulting in a new set of cost tradeoffs, and the Navy would need move to a new R&A mix.

We follow [2] and look at the following costs of increasing the number of accessions:

- Additional recruiters, and other recruiting resources for large changes
- Enlistment bonuses
- Training costs/salaries for trainees and instructors, and costs of added infrastructure for large changes.

The costs of increased reenlistment are:

- SRBs
- Seniority costs: increased (decreased) compensation costs due to more (less) senior force.

Given rising marginal costs and falling marginal benefits, an optimal level of reenlistments is where marginal cost is equal to marginal benefit for both R & A. One can show that this implies that the optimal mix of R & A exists where the marginal cost of reenlistment is equal to the marginal cost of accessions.

Accessions and reenlistments in the simulation model

We define "accessions" in year *t* as the number of personnel that are YOS 0 any time in year *t*. To increase accessions in year *t+1*, we just multiply accessions for year *t* by whatever percentage we want to raise accessions. So, for example, if accessions are 36,000 in year-1 and we want to increase accessions by 1 percent, year-2 accessions are simply (36,000*1.01 = 36,360).

"Reenlistment" in year *t* is the number of personnel who are EAOS in year *t* and stay to year *t+1*. If we want to increase total reenlistment by 1 percent, we must increase by 1 percent all the stay rates (i.e., the probabilities of stay given EAOS and YOS for the all service members from YOS 1 to YOS 19).

All changes to R&A in the model are based on year-1 rates. So, if we want to increase accessions to 36,360 and maintain that new accession rate, we simply multiply the year-1 rate by 1.01 each of the following years. If we want to increase accessions by 1 percent in year-2 and then raise the accession rate by 2 percent in year-3, we simply multiply year-3 accessions by 1.02. Then, expanding our example, year-2 accessions are (36,000*1.01 = 36,360), and year-3 accessions are (36,000*1.02 = 36,720).[4]

The three sets of parameters that come from our statistical models—accession rates, reenlistment rates, and attrition rates—allow us to forecast future distributions of personnel when there are changes in reenlistment and accession rates. Note that this simulation model will be useful in modeling small changes in reenlistment and accessions.[5]

4. This is a little different from raising accessions by an *additional* 1 percent in the second year, which would be 36,000*(1.01^2) = 36,723.6.

5. We suggest that the parameters used in the simulation model are appropriate for estimating small changes in reenlistment. Large changes in R&A could portend changes to the basic structure of the Navy's force and result in changes to the probabilities of stay. Further, the parameters in this model assume relatively stable elasticities of reenlistment with respect to pay and other incentives, which will be close enough for small changes, but might not be correct for large changes.

Costs

Costs of reenlistment and accessions

Rising marginal costs and falling marginal benefits

In addition to total costs of reenlistment and accessions, we are interested in understanding how recruiting costs change given a small change in accessions. Fixed costs remain constant when accessions change by a small amount, and will result in average costs falling. But we also care about how variable costs change with changing R&A and with changing economic conditions. So we will also focus on the variable recruiting costs.

Here we address the two issues related to marginal costs (MC) and marginal benefits (MB) of reenlistment and accessions.

1. Why do MC rise and MB fall?
2. How can we show rising MC and falling MB from the available data?

In the next sections, we'll show how we calculated the annual number of reenlistment and accessions, and how we estimated productive years. Then we'll look at each of the costs and the data we'll be using to represent these costs.

Accessions for select ratings

If we're going to compare accession and reenlistment costs, we need to define the terms. We've defined reenlistment as "stay," meaning that the service member was there at the beginning of the fiscal year, was at the end of his or her enlistment contract sometime within that fiscal year, and was still in the Navy at the beginning of the next fiscal year. The same definition would apply by rating since there are restrictions regarding reenlistments by service members who are unrated by the end of their first contract.

It's a little more complicated with accessions because not every service member ends up in their promised rating and some service members come in without a promise of a specific rating.

The way we counted accessions by rating is this. At the time of enlistment, recruits are either promised a rating or placed into a rating category called General Detail Enlistment (GENDET). which consists of Airmen (AN), Firemen (FN), and Seamen (SN). We consider a service member as an accession for a particular rating if he or she:

- Arrives to full duty status in that rating regardless of the rating promised
- Is promised that rating and attrites
- Is promised that rating, arrives full duty as a GENDET, but some time before the end of his/her first enlistment strikes for and gains that rating.

Productive years

Productive years are those active duty years that follow the accession or reenlistment event. For accessions, productive years happen after basic training and A-school (and, for some ratings, C-school) training. For them, productive years commence upon arriving at the first duty station.

We assume that reenlistment productive years begin immediately upon reenlistment. In reality, however, many retainees go to some higher level training.

Using data from the enlisted master personnel files of 1983 through 2007, we calculated the average continuation rates for each YOS to estimate the number of productive years the Navy can expect from an accession or a retainee. Continuation rates are simply the percentage of service members who are still in the Navy from one YOS to the next.

Those who don't continue include losses from EAOS and losses from attrition.

Accession productive years

We list continuation rates by YOS in table 2. In column three, we also show what these continuation imply for a notional 100 accessions. We see that of the 100 accessions (YOS 0), nearly 81 percent make it to YOS 1 on average. Although the losses will typically occur throughout the year, we know that around 19 of the 100 accessions did not spend a full year in the service. Of the 100, 71.1 make it to YOS 2, meaning that 28.9 of the accessions did not spend a full 2 years in the service. But we also know that 80.7 service members were in the service at least 1 year, and 71.1 were in the service at least 2 years, and so on.

Table 2. Continuation rates and expected productive years of 100 service members from accession to retirement eligibility

YOS at beginning of FY	Estimates of continuation rate	Remaining at YOS from 100 accessions
0	.81	100.0
1	.88	80.7
2	.85	71.1
3	.64	60.2
4	.83	38.7
5	.80	32.0
6	.89	25.4
7	.86	22.8
8	.89	19.7
9	.87	17.5
10	.93	15.4
11	.94	14.3
12	.95	13.6
13	.96	13.0
14	.96	12.5
15	.96	12.1
16	.97	11.7
17	.97	11.4
18	.97	11.2
19	NA	10.8
Total PY from 100 accessions		**493.8**

We define total productive years as the total number of service years given by those 100 accessions, minus the first year for training. Total productive years divided by 100 is the average number of productive years per accession.

Using this methodology, and continuation rates by YOS, we estimate that the Navy will get roughly 594 years of service for every 100 accessions from YOS 0 until retirement eligibility at 19.5 YOS, of which 494 will have been productive (post-training) years. That means an average of 4.94 years of productive service per accession.

Reenlistment productive years

Analogously, we estimate the average number of productive years for retainees, but with one added parameter: service members reenlist at various YOS, and so we need the probability that service members will be at the end of obligated service (EAOS) and the stay rate for those who are. This will give us the expected distribution of potential reenlistees by YOS, and will allow us to weight the average number of productive years by this distribution.

In table 3, the third column, we show the average proportion of service members of a given YOS who will stay in the military. We use the average number for normal economic conditions since that is the default expectation.

When the Navy retains 100 service members at YOS 4, it would expect them, at current continuation rates, to provide an estimated 728.8 productive years of service, for an average of 7.29 productive years per retainee.

Because personnel experience their EAOS at varying years of service, we use a weighted sum of productive years, in which the weighting is by the proportions of retainees at each YOS. So we estimate that the weighted average number of productive years for all YOS, for All-Enlisted, is around 6.9.

There are two reasons for caution in these estimates of productive years. First, service members may spend some time in their second or later tours in advanced training. Although this will make them more productive during the rest of their careers, that time is not itself productive time. This would tend to cause us to slightly *overestimate* actual productive years.[6]

Table 3. Table 3: Average proportion of service members of a given YOS who will stay in the military, from YOS 4 to 19

YOS at beginning of FY	Estimates of continuation rate	Remaining at YOS from 100 reenlistments
4	.83	100.0
5	.80	82.6
6	.89	65.7
7	.86	58.8
8	.89	50.8
9	.87	45.1
10	.93	39.6
11	.94	36.9
12	.95	34.9
13	.96	33.5
14	.96	32.3
15	.96	31.3
16	.97	30.3
17	.97	29.5
18	.97	28.8
19	NA	27.9
Total PY from 100 retained at YOS 4		**728.8**

Second, the reenlistment table was constructed by global continuation rates, which does not include actual attrition rates of personnel who sign new contracts at YOS 4. Continuation rates include all losses, including EAOS and attrition. Actual YOS 4 retainees will not typically include as many EAOS losses as overall continuation rates at YOS 4. This will cause our method to slightly *underestimate* actual productive years.

6. The data show that service members only spend an average of about 3 percent of their time in training after reaching their first duty station. So post reenlistment training wouldn't entail high training costs.

So, what's the theory behind productive years? Remember that we can choose between retaining one more person or accessing one more person at the margin. If we access someone, we'll expect that he or she will stay approximately 5.9 years and be productive for 4.9 of them. If we choose to retain someone, the expected number of productive years will depend on the year of service in which they were retained. For example, we expect those who retain when EAOS is at YOS 4 to give about 7.1 years of productive service. However, only about 5.4 percent of retainees will have their EAOS at YOS 4, so a weighted average number of productive years for retainees is about 6.9.

In the subsections that follow, we estimate average costs of reenlistment and accessions, and the effects of changes in reenlistments and accession on average costs.

Reenlistment costs

There are two categories of reenlistment costs: selective reenlistment bonuses (SRBs), and seniority costs (SENs).

SRBs

The Navy pays SRBs to elicit additional reenlistment, especially in certain critical ratings. The higher the SRB multiplier, the higher the bonus for reenlisting. We assume an average 4-year reenlistment and use the standard formula for translating this multiplier into an SRB dollar amount. The formula is:

$$SRB = M * BP/12 * 4, \tag{7}$$

where

SRB = the estimate of the dollar amount of the bonus

M = the SRB multiplier for each person in the year of his or her EAOS; the multiplier is set for a person in a specific rating and YOS zone

BP = the service member's annual basic pay for the YOS for the fiscal year.

The size of the reenlistment bonuses varies widely by rating, from zero for many ratings to quite large for others. Bonuses also vary over time for given ratings, as the Navy responds to different retention environments.

Hansen and Wenger [2] estimate that the SRB effect on reenlistments is about 2.5, meaning that a 1-point change in the multiplier will result in a 2.5 percentage point increase in reenlistment on average across the Navy. We use the inverse of this parameter in our calculations to estimate the potential effect of changes in reenlistments on the Navy's SRB costs. That is, we assume that, if a 1-point change in M results in a 2.5 percentage point change in R, the inverse is also correct: a 2.5 percentage point change in R would elicit a 1-point change in M in response.

Further, from the data, we see that a 1-point change in M implies, on average, about a 40-percent change in the SRB amount. It follows that a 1-percent change in reenlistment implies a $(.4/(2.5/R_t))$ percent change in SRB, where R_t is the current reenlistment rate (in decimal form). We use this parameter in the simulation model to capture the effect of changing the reenlistment rate on Navy's SRB costs. Hansen and Wenger [2} also show that this parameter varies by rating. We use the appropriate SRB effect parameters for each of our select ratings.

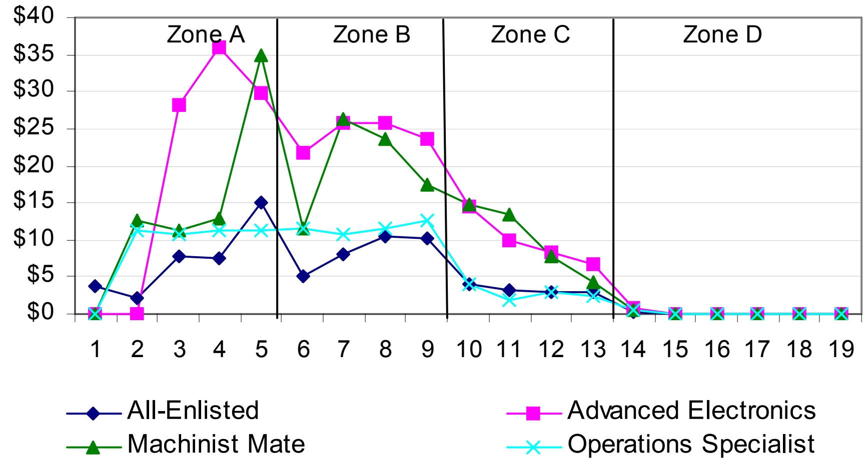
As we see in figure 6, the average SRB also varies widely by YOS in a consistent way across ratings, with the bonus for those service members in zone A (YOS 1–6) being higher than those in zone B (YOS 6–10), which is higher than for members in the next zone, and so on.

Seniority costs

Having a more senior force results in both costs and benefits to the Navy. The costs of a more senior force arise from the higher pay and benefits that accrue to a more senior workforce in the Navy. The benefit is that experienced Sailors have more expertise in their specialties and are likely to be more effective at performing their duties.

Seniority costs are an indirect cost of reenlistment. While SRB amounts are a result of a direct decision by the Navy to change SRBs in order to increase reenlistments, seniority costs vary as a result of the change in the distribution of junior and senior personnel that follows a change in reenlistment rates.

Figure 6. Average SRB by YOS for select ratings (in thousands of 2008$)



The conceptual way to think about seniority costs is that, if the Navy retains a person, it will pay the wages of a (relatively) senior service member for a number of years. However, it will receive a benefit in terms of more or higher quality output from the additional experience of that person for the post-reenlistment years. In our language here, "seniority cost" is the difference between the wages the Navy will pay and the benefit it will receive for that retainee.

Ideally, the Navy would pay a wage that exactly includes all the benefits from experience. The problem, of course, is that it is difficult—perhaps impossible—to accurately measure this benefit. There is no measure of "output" for military personnel, given that the final product is "readiness," which, in addition to being not measurable, is generally defined in a circular way by the Navy's ability to fill its own requirements, which are themselves a function of the nebulous concept of "readiness".

Nonetheless, we needed to find a measure of the benefit of experience. One can assume that firms in the private sector have an easier time estimating the benefits of an employee's experience, given that they typically have some final product to sell on the market, and the extent to which market competition forces firms to get it right (or at least very close). For the purposes of estimating seniority costs, we assume that this is correct.

We use statistical regression methods on private-sector data from the BLS's Current Population Survey to estimate what private-sector employees earn for additional years of experience and, consequently, what service members might expect to earn in the private sector for a given level of experience. We use these results for our estimates of the benefits of military experience.

We use the difference between the cost of military wages and expected private-sector wages as the measure of our components of "seniority costs." If military wages were exactly equal to benefits received by the Navy, there would be no seniority costs as we have defined them here.

The seniority cost of a retainee is the present value of the sum of the seniority costs for the number of years we expect from the reenlistment contract, which we assume is 4 years. Table 4 shows the tradeoff for gaining one accession vs. retaining one person at YOS 5.

Table 4. Example of calculating seniority costs for an accession and a retainee at YOS 5

	Cost in 2008 dollars		
YOS	Expected civilian wage (W_c)[a]	Cost of military wage (W_m)[b]	Seniority cost $[(W_m\text{-}W_c)/d^t]$[c]
5	$26,676	$37,774	$11,098
6	$31,414	$40,294	$8,538
7	$32,947	$41,182	$7,662
8	$35,261	$43,312	$9,214
Total Seniority Cost			$36,512

a. W_c is the person's expected civilian wage.
b. W_m is the Navy's cost of the military wage.
c. $(W_m\text{-}W_c)/d^t$ is the difference discounted by average Navy borrowing rate.

The total seniority cost is the discounted sum of all four years of reenlistment seniority costs for each individual retainee. In this example, that amount is $36,512.

Total reenlistment costs

In general, reenlistment costs have risen about 25 to 35 percent over the years 1999 to 2008 for All-Enlisted, MM, and OS ratings. For the Advanced Electronics ratings, the ups and downs were quite dramatic—about a 50-percent increase from 1999 to 2002, followed by a 50-percent fall from 2003 to 2004, followed by a 40-percent increase from 2006 to 2007. These changes resulted almost entirely from varying SRBs.

Accession costs

The three major costs of accessions follow:

- Cost of recruiters, recruiting support personnel, and recruiting marketing and advertising
- Cost of enlistment bonuses
- Cost of training, or, more broadly, the cost of paying personnel before they join the fleet and become productive Sailors.

To analyze the effect of changing accession rates on costs over the 1999–2007 period, we'll first look at the accession numbers.

Figure 7 shows accessions from 1999 to 2007 for All-Enlisted. Figure 8 shows accessions for the MM, OS, and Advanced Electronics ratings. There we also see a fall in accessions from 2000 to 2003, with a dramatic fall for the Advanced Electronics ratings. However, accessions rose with the Iraq War starting in 2003, and continued to rise until about 2006.

Enlistment bonuses

Enlistment bonuses are sums of money offered to potential recruits, partly to encourage enlistment and partly to channel recruits into critical ratings [13]. To the extent that these bonuses successfully do the former, we expect to see a relationship between the average EB and the total number of accessions for All-Enlisted. To the extent that they successfully perform the latter, we expect to see a relationship between them at the ratings level.

Figure 7. Accessions All-Enlisted

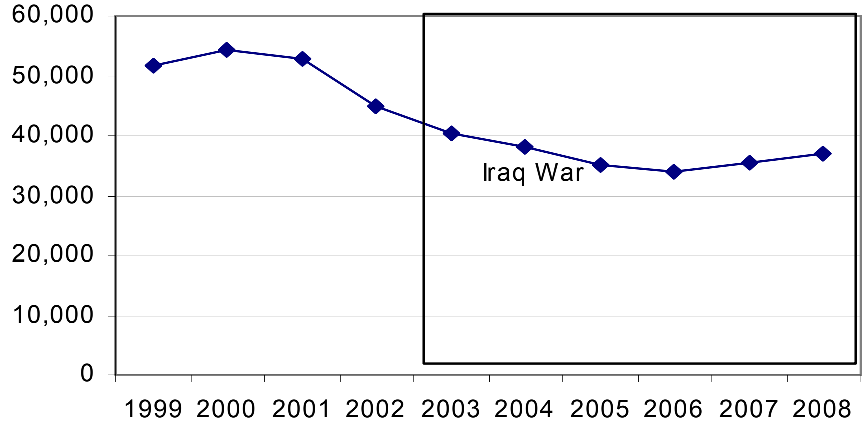
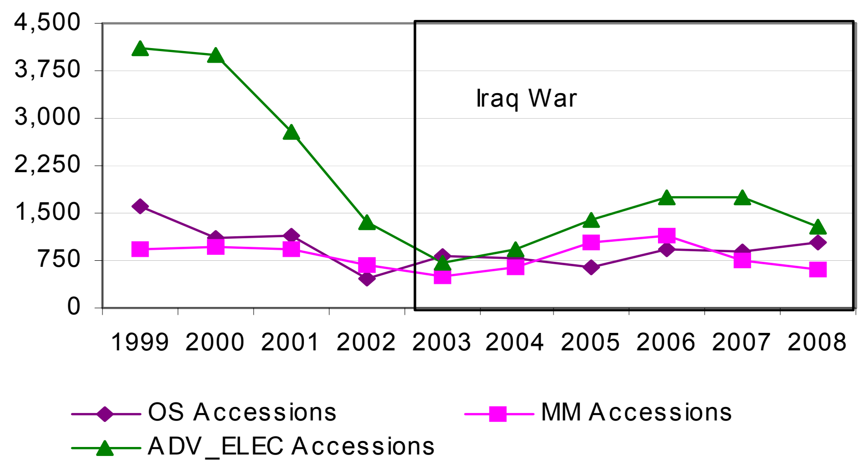


Figure 8. Accessions: OS, MM, & Advanced Electronics (ET and FC



Enlistment incentives—including enlistment bonuses (EBs), Navy College Fund (NCF), and loan repayment—are variable costs. As the number of recruits increases, the amount spent on enlistment incentives should increase as well, as it becomes increasingly more difficult to recruit new people.

Although the NCF is a type of enlistment bonus, its value is difficult to estimate. Not only was its value dependent on signing up for the

Montgomery GI Bill and attending university after leaving military service, it is not received for years after enlistment, so its value would be discounted over these years. Further, the data suggest that the use of the NCF as an enlistment incentive has declined dramatically over the last few years. We expect that NCF will not be used going forward because it has been effectively superseded by the Post-9/11 GI Bill. Finally, the Loan Repayment Program (LRP) has always been a tiny component of total enlistment bonuses. Consequently, we will not include the LRP or the NCF in our analysis and will focus exclusively on the enlistment bonus.

EBs might be expected to rise with increased recruiting to the extent that the Navy attracts the less expensive recruits first. The needed amount of the EB would be negatively correlated to a potential recruit's "propensity to enlist." According to [11], EBs don't increase recruiting, in general, but are most effectively used as incentives to become desired ratings. We see something like that in the data.

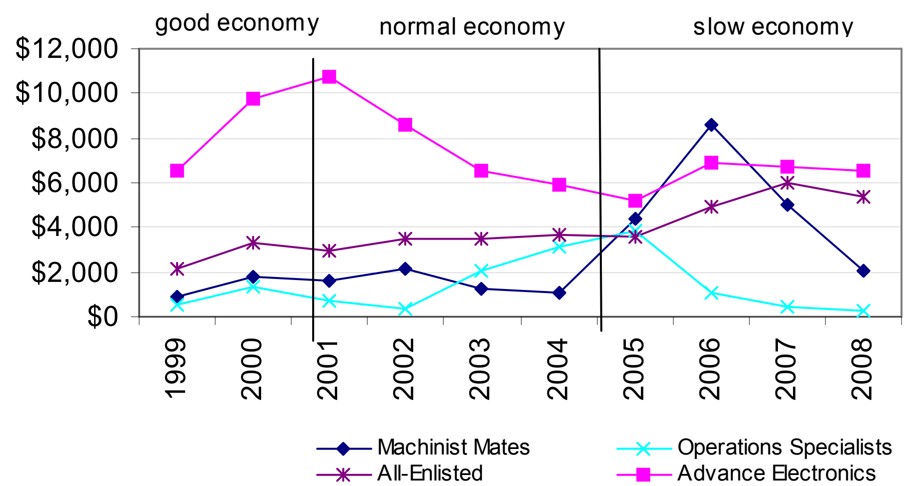
We have data from the Navy's PRIDE database for 1983 to 2007. However, we see in the data that EBs were not consistently or substantially employed until the late nineties, when increasing accessions became critical after years of drawdown.

We used the data on EBs from 1999 through 2007 to estimate average amounts and to estimate the relationship between changing EB and accessions. We don't find this relationship at the All-Enlisted level. However, we do find a strong positive relationship for the MM and the Advanced Electronics ratings, and a a small relationship for the OS rating. We use these parameters in the simulation model to estimate marginal cost of enlistment bonuses as accessions rise and fall.

Figure 9 shows how enlistment bonuses vary among ratings, and how they have varied over the years. The data do not reveal a strong relationship between these bonuses and economic conditions or with the number of accessions.

We don't see a strong correlation of average EB and economic conditions for any of the ratings or for All-Enlisted. For All-Enlisted, MM, and OS, average EB appears to be rising through all three types of economic conditions. For Advanced Electronics, EB appears to rise in good times and bad, and to fall during stable economic conditions. The bottom line is that there is a small positive correlation of average EB and accessions for individual ratings, when we control for the first 2 years of the Iraq War.

Figure 9. Average enlistment bonuses for select ratings and for All-Enlisted 1999-2008 (in 2008$)



Mostly what we see is that, when the Iraq War began, accessions for all three ratings went up, although for the OS rating only slightly and for a short time. At the same time, we see that average enlistment bonuses for MM and for Advanced Electronics when down for a few years. Only bonuses for OSs went up during the first couple of years of the war. That changed 2 years into the war when average enlistment bonuses went up for all three ratings and for the Navy as a whole.

Cost of the training pipeline

An additional cost related to the number of accessions is the cost of paying new service members as they move through the training pipeline. These costs include the cost of paying the trainees, the cost of paying the instructors, and infrastructure costs for the schools and classrooms. For our calculations of training costs, we again focus on costs that are variable for small changes in accessions. Both the trainee pay and the instructor pay are variable, but our data are limited to the cost of paying the trainees.

We calculate the training pipeline costs using student salaries times the number of training days plus the number of waiting days, plus the number of days between training and first assignment. We speculate that marginal cost of student training could rise and fall *with* strength requirements, as the number of waiting days could rise and fall when the Navy's demand for the skill rises and falls. Also, the number of waiting days for trained students between school and first duty assignment could rise and fall *inversely* to increases and decreases in Navy demand for the skill, as empty billets are quickly scooped up newly trained Sailors. So the effect of accessions of the student cost of the training pipeline is ambiguous.

We include only the cost to the Navy of paying the service members, which is our estimate of basic pay for a YOS 0, or YOS 1 for pipelines that last more then a year, and the 27 percent of basic pay retirement set-aside for the period of the pipeline.

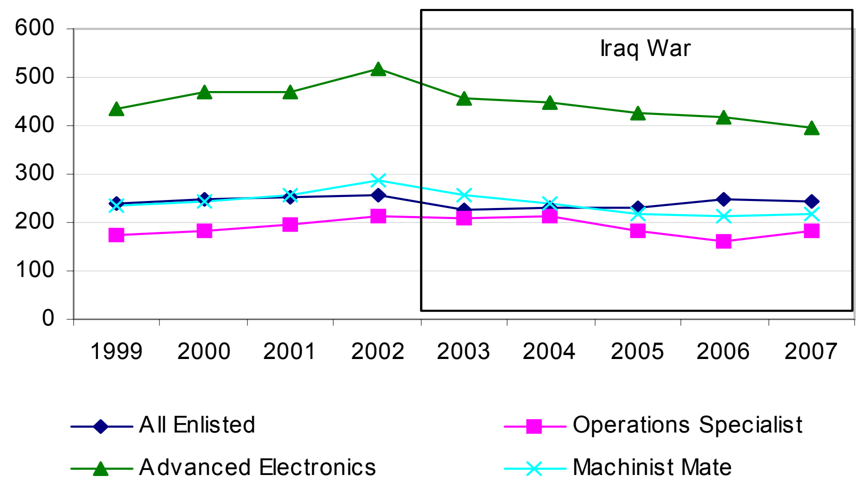
Training costs related to student days are in CNA's Street-to-Fleet (STF) database and in the IA accounts in the EMR data. To calculate the total cost of the students, we estimated the number of pipeline days for all accessions, including those who did not ever achieve full-duty status. The Navy spends money each year training students who attrite before completion, and this is part of the cost of accessions. We use the basic pay for each new gain and the length of training to calculate the cost of paying Sailors while they are in training, and we aggregate this for each fiscal year to generate total training costs.

Days and cost of training pipeline

In figure 10, we show the average number of days and average cost of the training pipeline for the three ratings and All-Enlisted. For the three ratings, we look only at “non-nukes”—those who did not enter the nuclear power specialties. The average new recruit took about 239 days to from street to fleet for All-Enlisted. This compares with the average OS accession, who took about 204 days, the average MM accession, who took about 280 days, and the average Advanced

Electronics accession, who took just over 500 days. Studying the numbers over time, we see no correlation of the length of the training pipeline and the number of accessions. Overall, even while accessions rose and fell over time, the length of the pipeline remained fairly stable, perhaps trending down a little for Advanced Electronics ratings.

Figure 10. Average number of days in the training pipeline for All-Enlisted and select ratings



Thus, the cost of the training pipeline appears to be a linear function of the number of days. Table 5 shows the average cost of the training pipeline for 1999 through 2007 for All-Enlisted and select ratings.

Table 5. Average cost of the training pipeline for All-Enlisted and select ratings, 1999 through 2007[a] (2008$)

Rating	Average cost 1999-2007
All-Enlisted	$10,127
OS	$8,639
MM	$10,892
Advanced Electronics	$20,308

a. Source: PRIDE 1999-2007.

Recruiters and recruiting support costs

The Navy hires civilians and military personnel to recruit new personnel into the military. It pays for buildings, equipment, and supplies to support them. And it conducts and pays for marketing and advertising to attract military recruits. Total recruiting costs are made up of the sum of the pay given to recruiting personnel, both civilian and military, and all the costs of support and marketing.

We have obtained recruiting cost data for 1979 to 2003 from the Department of Defense, Accession Policy office. The data are broken down into several categories: pay for recruiters, pay for civilians and other military support personnel, other support costs, advertising, and enlistment monetary incentives.

The pay for military recruiters is usually considered a variable cost. But the additional accessions will only increase average recruiting costs if additional personnel are added in disproportionate numbers. An increase in accession requirements by 2 percent that required an increase in recruiters by more than 2 percent would be an example where additional accessions caused an increase in average recruiting costs.

What does the data show? In figure 11, we see that when accessions rose in the late 1980s, there was an increase in military recruiting costs by about 30 percent. When accessions fell in the early 1990s, we saw a similar decline in real recruiting expenditures by roughly the same amount. Since about 1996, however, accessions have remained fairly constant, except for a very brief uptick around 2000, but costs have risen consistently since about 1994, and somewhat dramatically since about 1999.

This suggests that, while accession goals will vary from year to year, the average cost of recruiting changes for reasons unrelated to changing accession requirements.

This implies that marginal costs of recruiting from recruiter wages could be close to zero (figure 12). In fact, that's what we see; the correlation of accessions and recruiting costs is roughly zero.

Figure 11. Total recruiting costs: recruiters, recruiting support, and advertising (2008$)

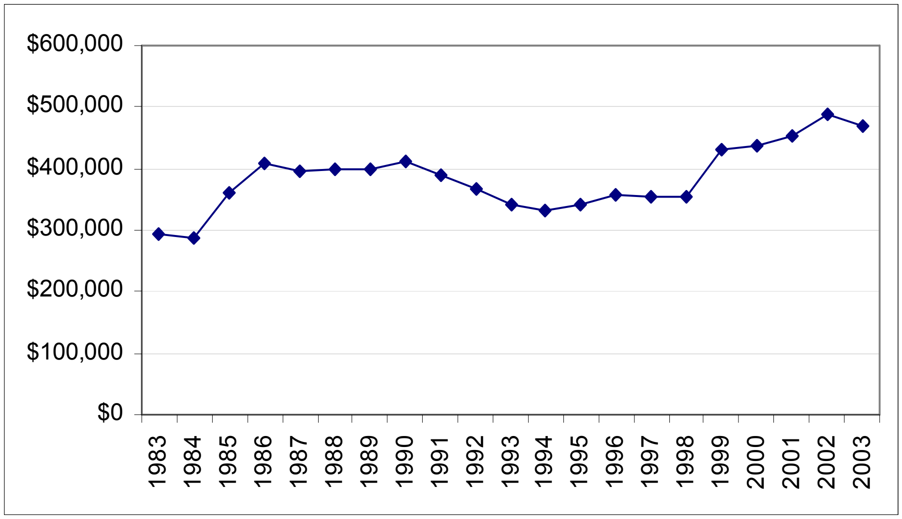
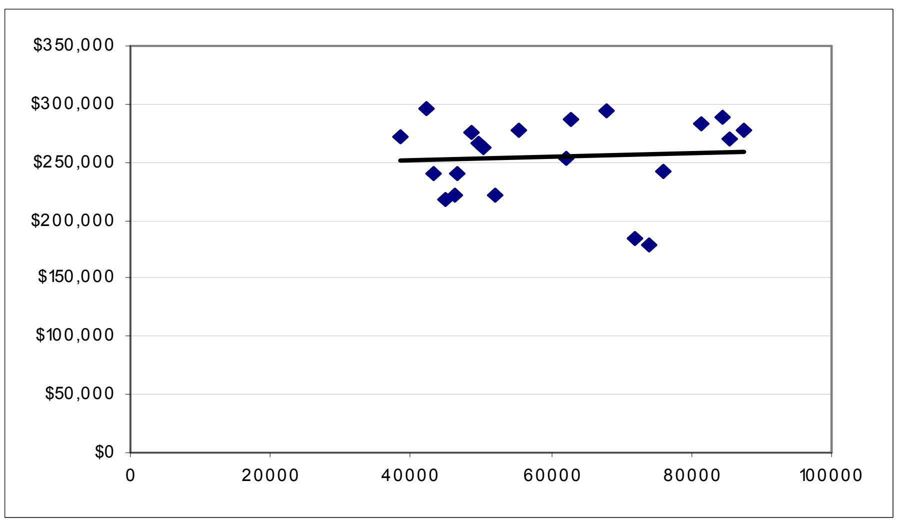


Figure 12. Correlation of accessions and total cost of military recruiters from 1983 to 2003



Thus, we find no consistent relationship between the number of accessions and the cost of recruiters after the buildup of the 1980s. What we do see is that, even as the number of accessions fell rather consistently year after year (with a brief period of small increases for a few years in the late 1990s), the total cost of recruiters, and the cost of recruiting in general, was either stable or rose quite substantially. The consequence of this was that the average cost of recruiting rose consistently.

Total cost of an accession

The total cost of an accession is the sum of each of the three costs. Because costs can change over the years for reasons unrelated to current cost tradeoffs,[7] we opt to use just the last 9 years of data for our analysis of costs.

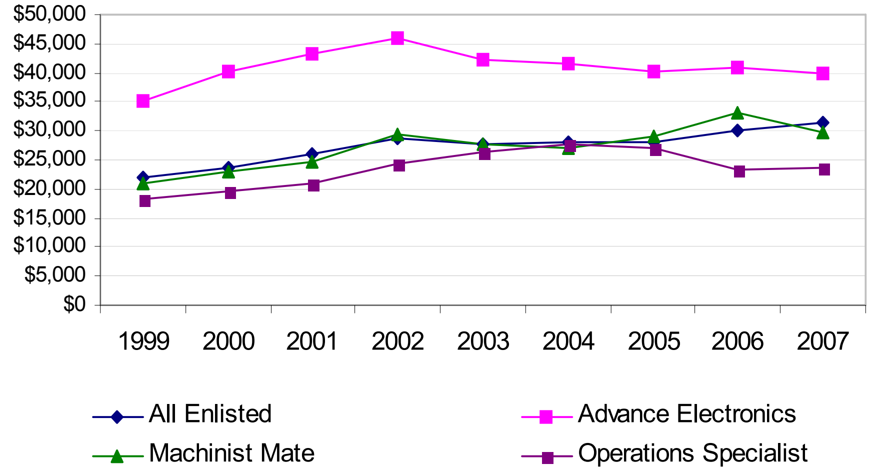
In figure 13, we show average accession costs for All-Enlisted and for our three select ratings from 1999 to 2007. In general, accession costs have risen, though at different rates for each of the ratings. Costs for accessing Machinist Mates rose from around $21,000 to almost $30,000, about 42 percent, in the 9-year period. Cost for the Operations Specialists rose at roughly the same rate from 1999 to 2004, and then fell nearly all the way back until 2007, when costs were about 27 percent higher than in 1999. Similarly, costs for accessions to the Advanced Electronics ratings rose steeply, from $35,000 to $46,000 in 1999 to 2002, but then fell slowly back to around $40,000 per accession in 2007.

Most of the variance in accession costs is due to changes in the enlistment bonuses because recruiting costs and training costs have been relatively stable over this period.

In the following sections, we present the results of our calculations.

7. For example, in the nineties and in the beginning of this decade, budgets for the Navy College Fund was roughly the same as for the straight Enlistment Bonus. In the last half-decade, however, use of the NCF has declined dramatically while use of EBs rose just as dramatically.

Figure 13. Average accession costs for select ratings, 1999–2007 (in 2008 dollars)



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Our simulations

We begin our scenarios at a starting distribution and cost structure, what could be called a steady-state condition. To emulate this condition, we use estimates of accessions and reenlistment rates (i.e., continuation probabilities at end of contracts) from 1983 to 2007. We input an initial distribution of personnel by YOS that is an estimate of averages over 1983 to 2007. We input average dollar amounts of accession and reenlistment costs from 1999 to 2007 data, inflated to 2008 dollars. Finally, we begin with numbers and distributions of total personnel for the entire Navy and for the three select ratings that are approximately what actually existed at the end of 2008.

Our objectives are to estimate marginal costs and changes to average costs that would follow changes in reenlistments and accessions, and that follow changes in national economic growth. In the first scenario, we simply change reenlistment and accessions by 1 percent, in opposite directions so that endstrength remains approximately constant. In the second, we change expectations about economic growth.

In both of these cases, the simulation model changes reenlistment rates by changing the probabilities of stay. The simulation assumes that these probabilities are changed as a result of changing SRBs, and returns the increase in SRBs necessary to induce these changes. Changing reenlistment rates also changes the distribution of junior and senior enlisted and the consequent seniority costs.

Similarly, changing economic conditions change the probabilities of stay, requiring the Navy to change SRBs to maintain endstrength. For example, a slow economy may increase the desirability of military life relative to life in the private sector, increasing stay rates, and allowing the Navy to reduce SRBs and yet maintain endstrength.

Simulated starting point total and average costs

In tables 6 through 9, we show the important R&A and cost numbers that result from our starting point, or "steady state" condition.

Table 6. Average and TOTAL cost estimates of reenlistments and accessions—All-Enlisted

All-Enlisted at simulation starting point	
Personnel	
TOTAL enlisted personnel	250,000
Annual reenlistments	28,880
Annual accessions	36,437
Reenlistment costs	
SRB per retainee	$5,692
SRB TOTAL	$164.4M
Seniority per retainee	$46,510
Seniority TOTAL	$1,343.2.4M
Accession costs	
EB per accession	$3,891
EB TOTAL	$141.78M
Training per accession	$10,127
Training TOTAL	$369.00 M
Recruiting per accession	$11,474
Recruiting TOTAL	$418.08M
TOTAL estimated cost of R&A	**$2,436.5 M**

Table 7. Average and TOTAL cost estimates of reenlistments and accessions—ADV_ELEC ratings

Advanced Electronics at simulation starting point	
Personnel	
Total enlisted personnel	23,000
Annual reenlistments	1,648
Annual accessions	2,696
Reenlistment costs	
SRB per retainee	$13,871
SRB TOTAL	$22.9 M
Seniority per retainee	$24,452
Seniority TOTAL	$40.3 M
Accession costs	
EB per accession	$9,074
EB TOTAL	$24.5 M
Training per accession	$20,308
Training TOTAL	$54.8 M
Recruiting per accession	$11,474
Recruiting TOTAL	$30.9 M
TOTAL estimated cost of R&A	**$173.3 M**

Table 8. Average and TOTAL cost estimates of reenlistments and accessions—MM rating

Machinist Mate at simulation starting point	
Personnel	
TOTAL enlisted personnel	10,000
Annual reenlistments	1,023
Annual accessions	1,193
Reenlistment costs	
SRB per retainee	$11,694
SRB TOTAL	$12.0 M
Seniority per retainee	$44,625
Seniority TOTAL	$45.6 M
Accession costs	
EB per accession	$5,208
EB TOTAL	$6.21M
Training per accession	$10,892
Training TOTAL	$13.00M
Recruiting per accession	$11,474
Recruiting TOTAL	$13.69M
TOTAL estimated cost of R&A	**$90.5 M**

Table 9. Average and TOTAL cost estimates of reenlistments and accessions—OS rating

Operations Specialists at simulation starting point	
Personnel	
TOTAL enlisted personnel	11,000
Annual reenlistments	1,291
Annual accessions	1,435
Reenlistment costs	
SRB per retainee	$7658
SRB TOTAL	$9.9 M
Seniority per retainee	$56,389
Seniority TOTAL	$72.8 M
Accession costs	
EB per accession	$660
EB TOTAL	$1 M
Training per accession	$8,639
Training TOTAL	$12.4 M
Recruiting per accession	$11,474
Recruiting TOTAL	$16.5 M
TOTAL estimated cost of R&A	**$112.5 M**

Scenario one

In our first scenario, we change the reenlistment rate by 1 percent and change the accessions rate in the opposite direction by an amount that is a little less than 1 percent, but just enough to approximately keep endstrength constant. Here our objective is to find an estimate of the marginal costs of each of the reenlistment and accession costs, and to estimate the effects of these changes on average costs.

In the sections that follow, we report 1) the average costs at the starting point for all five cost items, reporting both forms: per-retainee/per-accession, and per-productive year; 2) the marginal costs for each of the five R&A costs, and 3) the change in average costs after the R&A changes have been made.

Should the Navy increase reenlistments or accessions?

All-Enlisted

Across the Navy (an aggregate look at all enlisted personnel in the Navy), the *average per-retainee cost* of about $52,200 is more than double the *average cost per-accession*, which we estimate at around $25,500. However, the expected number of productive years by a retainee is greater, at roughly 6.9, than the expected number of productive years for an accession, at 4.9.

The average cost per *reenlistment productive year*, at $7,600, is also greater than the average cost per *accession productive year*, which is about $5,200. This suggests that, from an end-of-FY08 starting point, the Navy should increase accessions and / or reduce reenlistments.

We also found that the *marginal* cost for reenlistment is greater than the marginal cost of accessions. We estimate that, at the All-Enlisted level, a 1-percent increase in reenlistments, coupled with a roughly 0.8-percent decrease in accessions to hold endstrength constant, would increase reenlistment costs by about $30.8M the first year, while reducing accession costs by only about $7.4M, for an overall cost increase of about $23.4M. Of course, if the Navy were to do the reverse—increase accessions while decreasing reenlistment by 1 percent—the cost *savings* would be roughly the $23.4M. This is caused by a *marginal* reenlistment cost per productive year of about $15,500 and a *marginal* accession cost per productive year of about $5,200.

As we can see, at the All-Enlisted level, the marginal costs of an accession productive year is about the same as its average cost, while the marginal costs of a reenlistment is greater than its average. What we found in the data is that average accessions costs do not vary much with the total number of accessions. Recruiting costs change only very slowly, if at all, with accessions, and the costs of the training pipeline are multiples of the number of training days, which also doesn't vary much with accessions. Only enlistment bonuses appear to change with accessions, and then only for specific ratings.

The data show that reenlistment costs vary in a much greater way with the number of retainees than accession costs do with changes in accessions. We provide two explanations, each with a caveat. *First*, while SRBs, like EBs, are given for specific ratings, they are much larger in dollar amounts, and thus have a much larger effect on total reenlistment costs than EBs have on accession costs. Second, SRBs have been used for many years, and personnel managers in the Navy have a lot of knowledge and experience with them, so the amounts are very sensitive to the Navy's reenlistment needs.

The marginal cost of reenlistment is higher than its average as a result of SRB. If the Navy needs to increase the probability of stay for someone in a critical rating, it will need to increase the SRB. However, a one-price rule exists: if the Navy raises the SRB for one person, it will have to raise the SRB for all "like" personnel in the group, both because Sailors will expect it and because it would be difficult for the Navy to classify individual personnel in a given rating and zone.

The consequence is that marginal SRB costs will be greater than average SRB costs. Past studies have looked at the elasticity effects of SRB (i.e., what is the magnitude of the effect of an increase (or decrease) in SRB on reenlistments?). We follow the results in [2] that the SRB effect on reenlistment is about 2.5, meaning that a 1-point change in the multiplier (M) will result in a 2.5 percentage point increase in reenlistment on average across the Navy. We use the inverse of this parameter in our calculations to estimate the potential effect of changes in reenlistment on the Navy's SRB costs. That is, we assume that, if a 1-point change in M results in a 2.5-percent change in R, the inverse is also correct: a 2.5 percentage point change in R can be achieved by a 1-point change in M.

We estimate from the data that, on average, a 1-point change in M implies a roughly 40-percent change in the SRB amount. Adding in the SRB effect from [2] implies that a 40 percent change in SRB leads to a 2.5 percent change in stay rates. If we assume that, all else equal, changes in reenlistment result from changes in SRBs, we can estimate that a 1-percent change in reenlistment implies a $(.4/(2.5/R_t))$-percent change in SRB, where R_t is the current reenlistment rate (in decimal form).[8] We use this parameter in the simulation model to

8. Unlike for SRBs, changes in total seniority costs are result of, rather than a cause of, changing reenlistment.

emulate the effect of changing reenlistment on the Navy's SRB costs. The result is that, while the *average* SRB cost per productive year, for All-Enlisted, is about $5,700, the marginal cost per productive year of SRB is about $8,700 per additional retainee.[9]

Average and marginal seniority costs, about $6,700 per retainee productive year, are quite a large part of overall reenlistment costs. We need to caveat these results, however. Recall that the calculations of seniority costs follow three assumptions. Our calculations of seniority costs are sensitive to the extent these assumptions are correct.

First, we assume that the private sector, as a result of competitive pressures, correctly prices the benefits it receives from the experience levels of workers.

Second, we assume that the value of the benefits to experience in the private sector and to the military are about the same. This assumption is difficult to quantify because, while private-sector output must sell in a competitive market, there is no comparable measure for military output. Also, private-sector workers and service members may not gain experience at the same rate of speed because private-sector workers and service members do not share the same pattern of moving from job to job and field to field.

Third, an implicit assumption in this method of estimating seniority costs is that gains to productivity are constant, regardless of the relative proportions of junior and senior personnel. It is likely the case that the added value of an additional experienced person will vary, perhaps strongly, by the relative distribution of junior and senior personnel.

Marginal accession costs are substantially less than marginal reenlistment costs. Of the three accession costs, only the enlistment bonus has a behavioral effect that can lead to large marginal costs. The enlistment bonus is sometimes used to increase accessions. To the extent that it works to increase the probability of potential recruits

9. All dollar amounts are inflated to 2008 dollars, to make them both consistent and timely.

enlisting, and to the extent that the Navy uses the bonus effectively in this manner, marginal bonus costs will be greater than the average. However, studies such as [13] have shown that enlistment bonuses are far more effective at drawing recruits toward specific ratings than they are at actually increasing the number of total accessions. In the data, the average enlistment bonus is about $3,900, and there doesn't appear to be an effect of average enlistment bonuses on changing accessions, at least not in the All-Enlisted average.

Similarly, the average costs of the training pipeline, which are primarily made up of wages for students, don't change much with increases and decreases in the number of accessions. We had speculated that waiting periods might fluctuate with the number of accessions, but we don't see that in the data either. This suggests that resources for training support move up and down fairly smoothly as the number of accessions rise and fall.

As a result, we expect that marginal costs of the training pipeline are roughly equal to the average costs; the data bear this out. For All-Enlisted, the average and marginal cost per accession is about $10,100, and per productive year, about $2,100.

About two-thirds of recruiting costs are wages paid to military recruiters. The other third are wages to civilian recruiting support personnel, other recruiting support costs, and advertising. With data obtained from the office of Navy Accessions Policy, we estimate that the average cost of recruiting is about $11,500, making the average per productive year about $2,300. The marginal cost of recruiting is not larger, and might be smaller, than average costs because, while they are certainly variable costs, they typically vary by fiat, and historically have not changed rapidly with accessions. Instead, we see that the productivity of recruiters and recruiting resources rises and falls with accessions, while total costs remain flat for long periods before adjusting to accessions. Thus, we see that average costs will decline with rising accessions and vice versa. This suggests that marginal costs of recruiting could be *less* than the average.

Results for scenario one All-Enlisted *reenlistment costs:*

- Starting point cost per retainee: $52,202

- Expected productive years of a retainee: 6.9
- Average cost per reenlistment productive year: $7,566
- Marginal costs per retainee: $106,847
  - Marginal SRBs: $60,327
  - Marginal Seniority: $46,510
- Marginal reenlistment cost per productive year: $15,485
- Marginal SRB cost per productive year: $8,743
- Marginal Seniority cost per productive year: $6,741.

Scenario one results for All-Enlisted *accessions costs*:

- Starting point cost per accession: $25,493
- Expected productive years of an accession: 4.9
- Average cost per accession productive year: $5,203
- Marginal cost per accession: $25,493
  - Marginal EB: $3,891
  - Marginal TRAIN: $10,127
  - Marginal RECRUIT: $11,474
- Marginal accession cost per productive year: $5,203.[10]

Select ratings

We repeated scenario one in our simulations for four select ratings, two of which we combined into one rating category. The ratings are: Machinist Mates (MM) and Operations Specialists (OS), and we combine Electronics Technicians (ET) and Fire Control Technicians (FC) into a category we call Advanced Electronics (ADV_ELEC).

10. The fact that we report the numbers to the nearest dollar in our data does not indicate the level of accuracy of our measures of each of these costs. They are averages over 25 years of data, and thus a rough estimate.

We used the same methods to estimate average and marginal costs for each of these ratings. Average cost of reenlistment will vary among ratings to the extent that Navy chooses different SRB multiples and to the extent that distribution of junior and senior personnel differ among ratings.

We find, not surprisingly, that the marginal SRB is quite large for the ADV_ELEC, but also that average seniority costs are relatively low. Conversely, marginal SRB for Operations Specialists are lower than average, while their marginal seniority costs are higher than average. Marginal costs for Machinist are roughly the Navy average. Both the SRB effects and the seniority costs effects appear to reflect the difference between private sector and civilian wages for the rating, with civilian wages being high for electronics technicians, and lower for OSs. The reasons for the difference are partly because of the high level of training, and partly because OS skills are relatively Navy specific while advance electronics skills are easily transferable to the private sector.

Here are results from scenario one for *reenlistment* costs for ADV_ELEC:

- ADV_ELEC starting point cost per retainee: $38,323
- Expected productive years of a retainee: 6.7
- Starting point average cost per reenlistment productive year: $5,720
- Marginal costs per retainee: $144,288
  - Marginal SRBs: $119,836
  - Marginal Seniority: $24,452
- Marginal reenlistment cost per productive year: $21,535
- Marginal SRB cost per productive year: $17,886.

Here are results from scenario one for *reenlistment* costs for MM:

- MM starting point cost per retainee: $56,319
- Expected productive years of a retainee: 7.3

- Starting point average cost per reenlistment productive year: $7,715
- Marginal costs per retainee: $99,171
  - Marginal SRBs: $55,546
  - Marginal Seniority: $44,625
- Marginal reenlistment cost per productive year: $13,585
- Marginal SRB cost per productive year: $7,609.

Here are results from scenario one for *reenlistment* costs for OS:

- OS starting point cost per retainee: $64,047
- Expected productive years of a retainee: 6.3
- Starting point average cost per reenlistment productive year: $10,166
- Marginal costs per retainee: $104,578
  - Marginal SRBs: $48,189
  - Marginal Seniority: $56,389
- Marginal reenlistment cost per productive year: $16,600
- Marginal SRB cost per productive year: $7,649.

Results on cost of accessions for select ratings A large component of differences in accessions costs among ratings is due to varying length of the training pipeline. For example, average training time is 280 days for students in the non-nuclear field MM pipeline, 508 days for those in the non-nuclear ADV_ELEC, and 208 days for the OS rating. Training costs are a linear function of the number of days, and so average training costs are about $10,900 for MM, about $20,300 for ADV-ELEC, and about $8,600 for OS.

Enlistment bonuses are another way that marginal costs are different at the level of select ratings and at the All-Enlisted level. Where we did not detect anything in the data that suggested that the average bonus was correlated with accessions at the All-Enlisted level, we did find evidence that, at the individual rating level, enlistment bonuses and accessions were positively correlated. This implies that the marginal cost of the bonuses will be larger than the average cost. We factored these coefficients of correlation into our calculations.

Here are results from scenario one *accessions* costs for ADV_ELEC:

- Cost per accession: $40,856
- Expected productive years of an accession: 7.5
- Average cost per accession productive year: $5,447
- Marginal cost per accession: $44,365
  - Marginal cost of EB: $12,634
  - Marginal cost of TRAIN: $20,308
  - Marginal cost of RECRUIT: $11,474
- Marginal accession cost per productive year: $5,915.

Here are results from scenario one *accessions* costs for MM:

- Cost per accession: $27,574
- Expected productive years of an accession: 7.6
- Average cost per accession productive year: $3,628
- Marginal cost per accession: $34,948
  - Marginal cost of EB: $12,582
  - Marginal cost of TRAIN: $10,892
  - Marginal cost of RECRUIT: $11,474
- Marginal accession cost per productive year: $4,598.

Here are results from scenario one *accessions* costs for OS:

- Cost per accession: $20,774
- Expected productive years of an accession: 6.1
- Average cost per accession productive year: $3,406
- Marginal cost per accession: $20,855

— Marginal cost of EB: $742

— Marginal cost of TRAIN: $8,639

— Marginal cost of RECRUIT: $11,474

- Marginal accession cost per productive year: $3,419.

Scenario two

In this next scenario, we look at the effects changes in national economic conditions have on reenlistment and accessions. Recall from previous sections that we estimated stay and attrition rates with standard regression models. Included among those parameters were coefficients on indicators of economic growth. We defined normal, or average, economic growth as being between 2 and 4 percent, high growth as being over 4 percent and slow growth as being below 2 percent. We include these coefficients as parameters in our simulation model.

We found that high economic growth reduces reenlistment rates and increases attrition probabilities, while slow growth increases stay rates and reduces attrition (see tables 10 and 11). Neither of these outcomes were unexpected. What was unexpected was the different magnitudes of the effects. For high growth, while the effects were statistically significant, they were relatively small. Conversely, a slow growth economy not only had the opposite effects, the effects were comparatively large.

Table 10. Average attrition rates (percent of active that attrite) for all YOS

	U.S. economic growth		
Ratings	Slow	Normal	High
All-Enlisted	6.1	7.6	7.9
ADV_ELEC	4.4	6.5	6.5
MM	5.9	8.0	8.7
OS	6.0	7.6	8.4

Table 11. Average change in reenlistments (those who are EAOS who stay) compared to normal economic growth

Ratings	U.S. economic growth	
	Slow	High
All-Enlisted	+ 3.2	- 0.65
ADV_ELEC	+ 3.9	-0.03
MM	+ 4.9	-1.8
OS	+ 3.5	-1.8

First, notice that, while the differences in attrition rates between normal and high growth are very small, the differences between normal and slow growth are relatively large.[11] Looking at normal and high growth, for All-Enlisted, attrition goes from 7.6 percent during normal times to 7.9 percent in high growth periods, a small difference. For people in the advanced electronics ratings, there is practically no difference at all.

Similarly, the changes to stay rates as a result of going from normal to high growth are not large. For example, for All-Enlisted, a high growth economy will, all else equal, lead to only about six-tenths of a percent change in the number of people who reenlist compared with a normal economy. But going from normal to slow growth will lead to 3.2 percent decline in reenlistments.

A second item related changing economic conditions is the potential for changes to the distribution of junior and senior enlisted as a result and how this is related to Navy's consequent R&A decisions.

Reenlistment is substantially more sensitive to a move from a normal to a slow economy, and because we are now witnessing a slow economy, we will focus on our results from our simulations for a slow economy.

11. All rates in tables 10 and 11 are a result of "all else equal" changes in attrition and reenlistment rates due to changes in economic conditions. This means that, at least conceptually, all other parameters in the model, such as SRBs and EBs, are held constant.

Because in a slow economy, stay rates rise and attrition rates fall, total end strength would rise, all else equal. In fact, the Navy could have a difficult time keeping total strength down to prior levels, since changes in reenlistment rates are influenced by the Navy rather than controlled. Accessions, on the other hand, are more controlled, since they are a direct function of recruiter productivity.

Two strategies within scenario two

We'll look at two possible Navy strategies for dealing with the effects of a slow growth economy.

1. The Navy takes efforts to reduce the new (higher) reenlistment rates and accessions equally across all YOS.
2. The Navy focuses reenlistment reduction efforts on Zone A personnel exclusively and reduces accession rates by nearly double the rate from 1.

For each of these strategies, we'll look at the effect on the junior-senior distribution of the force for All-Enlisted and for the selected ratings.

If the Navy did not change either reenlistment rates or accessions, or were to take efforts to reduce reenlistment and accessions (from the new higher rates) *equally* by some percentage for all YOS, the ratio of junior to senior enlisted would not be affected very much. The relative number of junior enlisted could rise (a little) at first, as stay rates of zone A reenlistees are more sensitive than those of senior enlisted. However, if the slow economy lasted more than a year or two, and as these reenlistees grew in seniority, eventually the Navy would begin to get more senior. Table 12 shows how the ratio of junior to senior enlisted could change over a three-year period of slow economic growth where the Navy were to take efforts to reduce reenlistment and accessions equally across the board. As we see, the effect on the junior-senior distribution is very small for All-Enlisted and for all three of our selected ratings.

On the other hand, the Navy may want to focus on reducing reenlistment of Zone A personnel exclusively, since this could have a much greater effect on cost savings. First, Zone A personnel are a larger group; second, their SRBs are larger on average; and third, a larger proportion of them are eligible for SRBs. Also, for practical purposes, if SRBs become zero for some ratings, the Navy can involuntarily release Zone A personnel.

Table 12. Proportion of the force that is junior, over a three-year period of slow economy (reenlistments and accessions are cut equally across the board)

Rating	Starting average	Year 1	Year 2	Year 3
All-Enlisted	60.4	60.4	60.3	60.0
ADV_ELEC	58.5	58.6	58.3	57.9
MM	56.1	56.3	56.0	55.5
OS	60.3	60.5	60.4	59.9

Simulating a focus on reducing Zone A reenlistments and cutting accessions in a prolonged slow economy, we find that the Navy does become a little more senior almost immediately. We see in table 13, that the proportion of junior enlisted (at the All-Enlisted level) could fall from 60.4 percent in the year just prior to the beginning of a slow economy, to about 59.2 percent by the third year of slow economic growth.

Table 13. Junior enlisted proportions over a three-year period of slow economic growth (zone A reenlistments and accessions cut exclusively)

Rating	Starting average	Year 1	Year 2	Year 3	Potential J:S distribution
All-Enlisted	60.4	60.2	59.8	59.2	57.0
ADV_ELEC	58.5	58.3	57.9	57.2	54.4
MM	56.1	56.0	55.6	54.8	51.0
OS	60.3	60.2	59.8	58.9	56.0

Additionally, once the economy returns to normal, even if the Navy resumes it's normal reenlistment and accessions efforts, the Navy would continue getting more senior for a few years. In the last column of table 13, we show that under these circumstances, the Navy's proportion of junior enlisted could fall as low as 57 percent before beginning its return to the prior distribution. For our select ratings, the distributions begin a little more junior than the Navy as a whole, and under the scenario described here, could fall to 54.4 percent (ADV_ELEC), 56.0 percent (MM), and 51 percent (OS).

The point of this exercise is to show that the potential dollar costs or cost savings is only one criteria in making tradeoffs in reenlistments and accessions in the face of changes in endstrength requirements or economic conditions. Another set of tradeoffs involves how the distributions of junior and senior personnel will look after the R&A changes have been made.

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Conclusions

There are two major issues: First, it is commonly thought that is cheaper for the Navy to retain than to access because of high early attrition rates for accessions and because of the large costs of recruiting and the training pipeline. But, consideration of seniority costs makes reenlistment costs at least as high and probably higher than accessions costs, even when one considers the higher number of expected productive years of a retainee relative to an accession.

Second, even if seniority costs are not considered, *marginal reenlistment costs* are higher than *marginal accessions costs*. This is because SRBs must be raised (or can be lowered) to increase (or decrease) reenlistment. But with the one-price rule, when SRBs are changed for one they must be changed for all. Accessions costs largely don't suffer this effect; while the marginal cost of EBs are higher than their average, the effect is not large.

Implications of the one-price rule for SRBs

The marginal cost of SRB is substantially greater than its average cost. There are two reasons for this. First, labor supply curves are upward sloping as long as workers are willing to supply more labor at a higher price. Reenlistees are no different. If the Navy uses SRBs effectively, then to coax additional service members to reenlist, Navy will need to pay them higher SRBs. But, secondly, because of the "one-price" rule for SRBs, individuals who are eligible for reenlistment and who are in the same rating, rank, and YOS will be eligible for the same SRB amount. As a result, if the Navy gives a higher SRB to the few who require it, then it'll have to pay the higher SRB to all those who would have reenlisted at the lower rates.

The one price rule means that marginal cost of SRB is:

$$\frac{SRB_{t+1} * \Delta R - \Delta SRB * R_t}{\Delta R} \quad (8)$$

Where:

SRB_{t+1} is the new higher (or lower) SRB,

R_t is the original number of retainees;

ΔR and ΔSRB are the increase (or decrease) in reenlistment and SRB respectively.

If $SRB_{t+1} > SRB_t$, for example, equation (6) just shows the new group of retainees (ΔR) getting the new higher SRB, and the original group of retainees (R_t), who would have accepted the lower SRB, now requiring the new higher SRB. This is the result of the one-price rule.

Enlistment bonuses

Economic theory would suggest that the marginal cost of enlistment bonuses is greater than its average cost. After all, enlistment bonuses should rise to the extent the supply of recruits is upward sloping. Of course, EBs wouldn't suffer the one-price rule nearly to the extent of SRBs since new recruits wouldn't be as sophisticated about these matters as experienced sailors. In fact, recruiters may have some flexibility in their EB offerings.

However, there's not much evidence in the data that EBs have increasing marginal costs at all, at least not for All-Enlisted. Marginal cost of EBs are a little greater than the average at the ratings level. However, the differences are small.

Consequence of large marginal reenlistment costs

One could argue that seniority costs are not an accurate estimate of the true cost of reenlistment. It is difficult to match civilian with military occupations. For example, Navy Machinist Mates may do many similar tasks of mechanics, but many of their duties are unique to the Navy. Second, age might not be the best indicator for civilian experience, since civilians change jobs more often in the early years of their careers, and the Navy probably gives junior service members greater responsibilities than do private sector firms.

Finally, estimates of seniority costs assume a constant benefit of additional experience for a given YOS. In reality, the benefit received by additional experience for any YOS will vary with the distribution of juniors and seniors. One can imagine a Navy unit, for example, in which there were very few senior people deriving a great deal of benefit from adding one more senior person. Or, conversely, another unit that already has many senior people deriving very little additional benefit.

Potential costs or cost-savings is only one outcome to consider when making reenlistment and accessions decisions. The Navy should also consider the effects of R&A strategies on the current and future seniority distributions of personnel.

Economic conditions will also influence Navy's reenlistment and accessions decisions through their effects on personnel stay and attrition rates. But the context of the changes in the economy matters. Results from the models suggest that periods of high economic growth do not influence stay and attrition rates nearly as much as do periods of slow growth. In fact, a slow economy can increase stay rates and decrease attrition enough make it difficult for the Navy to keep from exceeding strength targets. The Navy is seeing this now, as it reduces SRBs to zero for many ratings.

Further, various R&A strategies can affect the seniority distribution of personnel in following years, even after the economy has returned to normal. We have found, for example, that if the Navy were to reduce reenlistments and accessions equally (i.e. by the same percentage for all YOS), junior-senior ratios would largely remain the same, perhaps becoming a little more senior in future years if the slow growth period persists. However, if the Navy were to focus on reducing reenlistments for Zone A personnel and accessions, perhaps in an effort to avoid breaking faith with the career force, the Navy could quickly start becoming more senior, and if it were a long period of slow growth, it could be difficult to reverse the trend.

Recommendations

In general, when marginal costs of one decision are high relative to another, it will be cost-effective to reduce that activity. So, in these examples, since marginal costs of reenlistment are high, it will be cost-effective to reduce reenlistments relative to accessions at the current levels. Thus, in the current period of decreasing endstrength, the Navy will save money by reducing reenlistments relative to accessions.

Even if one does not accept that seniority costs accurately estimate the value of benefits to experience for military people (and disregards them completely), marginal SRBs alone can be higher than marginal accession costs. Marginal SRBs have varied widely with reenlistment rates, whereas neither average enlistment bonuses nor average training costs nor average recruiting costs have varied much with changing accessions.

Also, during periods of slow economic conditions, high stay and low attrition rates will raise reenlistment rates and lower attrition rates. The results of our model suggests that it will be difficult for the Navy to reduce reenlistment (from the new, higher rates) enough to keep from exceding prior endstrength. In addition to marginal savings in SRB and EB costs, varying Navy strategies to retain the correct number of people will have consequences on the distribution of junior and senior personnel, even after economic conditions return to normal.

The U.S. is currently going through a period of slow economic growth. The Navy is finding that it can reduce SRBs to zero for some ratings and still maintain adequate strength levels. Because of the nature of reenlistment elasticity modeling, our model cannot consider the effects of fully eliminating the SRB on today's and future reenlistment. However, the Navy should take caution in case this strategy dramatically affects the distribution by seniority.

Of course, when SRBs are dropped to zero, then marginal SRB for additional reductions in reenlistment is also zero (because there is no such thing as a negative SRB). In that case, other factors related to reenlistment and accessions, such as their effects on the seniority distribution of the rating community or the total force, will prevail.

Additional research is needed in three areas. First, this study reflects a "model development" phase of this line of research. A second phase of research is needed to explore the application of this model to a variety of scenarios and to formulate the resulting policy implications. Second, in the models in the literature, the elasticity of reenlistment with respect to SRBs is assumed to be constant. This is not necessarily correct, and some kind of statistical method for estimating changes to elasticities needs to be used. Third, the benefits to experience are assumed to be accurate across ratings and constant on average. This might be correct at the moment, since junior-senior distributions are currently about average (junior-to-senior distributions were about 70:30 in the 1980s, moved to about 50:50 in the 1990s, and now are around 60:40). However, some methods need to be employed that can estimate the value of experience across a wide range of junior-senior distributions.

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Appendix A: Distributions

Table 14 lists the probability that the service member is facing the EAOS at current YOS.

Table 14. Probability sailor is EAOS at current YOS: All-Navy

YOS	Probability EAOS at YOS
0 (accessions)	0.00
1	0.03
2	0.10
3	0.54
4	0.25
5	0.30
6	0.18
7	0.27
8	0.24
9	0.32
10	0.20
11	0.21
12	0.20
13	0.23
14	0.22
15	0.26
16	0.23
17	0.18
18	0.18
19	0.52

Data: Enlisted Master Records, 1983-2007

Probabilities may not sum to 1 due to rounding

Table 15 lists stay rates by YOS and economic conditions.

Table 15. Probability of stay for given YOS and economic conditions

YOS	Stay ratios Good economy	Stay ratios Normal economy	Stay ratios Slow economy
0	NA	NA	NA
1	0.22	0.22	0.26
2	0.32	0.32	0.32
3	0.41	0.41	0.45
4	0.50	0.50	0.55
5	0.50	0.51	0.53
	0.58	0.59	0.63
7	0.61	0.62	0.66
8	0.67	0.68	0.71
9	0.72	0.73	0.75
10	0.78	0.79	0.81
11	0.82	0.82	0.84
12	0.82	0.86	0.88
13	0.86	0.89	0.90
14	0.89	0.91	0.92
15	0.92	0.93	0.94
16	0.94	0.94	0.95
17	0.95	0.96	0.96
18	0.96	0.97	0.97
19	0.97	0.97	0.98

Data: Enlisted Master Records, 1983-2007

Probabilities may not sum to 1 due to rounding

Appendix B: Regression results

Table 16 has the results from the regression. We use the results from this regression to calculate predicted expected civilian earnings for our sample of Sailors.

Table 16. Civilian wage regression results

Variable	Coefficient	t-statistic
High-tech occupation	0.25	45.07
Medium-tech occupation	0.08	20.90
White	0.02	5.54
Married	0.05	15.99
Female	-0.23	-58.87
Associate's Degree	0.10	33.55
Children	-0.02	-6.13
Age Group 2 (25-28)	0.21	35.46
Age Group 3 (29-32)	0.30	49.83
Age Group 4 (33+)	0.41	83.12
Survey Year 1983	0.02	1.96
Survey Year 1984	0.04	3.34
Survey Year 1985	0.05	4.33
Survey Year 1986	0.06	5.45
Survey Year 1987	0.06	5.56
Survey Year 1988	0.05	4.49
Survey Year 1989	0.01	1.05
Survey Year 1990	0.02	1.48
Survey Year 1991	0.00	-0.23
Survey Year 1992	0.00	0.39
Survey Year 1993	0.00	0.27
Survey Year 1994	0.00	-0.29
Survey Year 1996	-0.03	-2.58
Survey Year 1997	-0.01	-0.93
Survey Year 1998	-0.01	-0.51
Survey Year 1999	0.00	0.23
Survey Year 2000	0.02	1.43

Table 16. Civilian wage regression results (continued)

Variable	Coefficient	t-statistic
Survey Year 2001	0.03	2.60
Survey Year 2002	0.03	2.88
Survey Year 2003	0.04	4.53
Survey Year 2004	0.05	5.16
Survey Year 2005	0.03	3.09
Survey Year 2006	0.03	3.10
Survey Year 2007	0.03	2.86
Survey Year 2008	0.01	1.44
Constant	10.09	957.53

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