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Compensation and Enlisted Manning Shortfalls

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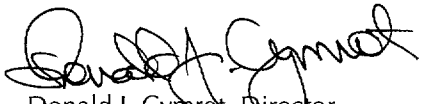

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Background

One of the biggest issues of concern to military personnel is the military "pay gap." Many are troubled by the possibility that the level of military pay has declined significantly relative to that of civilian wages. A common concern is that a civilian-military wage differential will quickly lead to retention and recruiting problems for the military. Furthermore, many in the Navy believe that these differentials are more prevalent in some ratings than in others—specifically, that the highly technical ratings are having the largest retention and recruiting problems as a result of relatively high civilian pay.

Objectives

Given these concerns, the objective of this study is to examine the correlation between manning shortfalls in various Navy enlisted ratings and the relative earnings of enlisted personnel in these occupations. We also examine differences in military compensation from one rating to another and compare these differentials with those in the civilian sector. In addition, we examine the relationship between military compensation and the propensity to reenlist, using our new measure of occupation-specific relative military compensation. This analysis yields estimates of the responsiveness of reenlistment rates to changes in relative pay, which can be used to estimate the change in compensation necessary to achieve manning level targets on a rating-by-rating basis.

Data and methodology

Our strategy for identifying manning problems is to examine, on a rating-by-rating basis, the proportion of authorized, active-duty billets that are filled. This examination of manning levels allows us to assess

the degree to which ratings are undermanned, if at all, and how these manning levels have changed over time. Our data on the number of individuals and the number of authorized billets in these ratings come from the Enlisted Master Record data (EMR) and from CNA's billet file, which is an extract from the Total Force Manpower Management System (TFMMS) data. We focus on the proportion of authorized billets filled for paygrades E-4 through E-6 to establish a link between this measure of manning shortfalls and zone A reenlistment decisions.

When examining the relationship between relative military compensation and enlisted retention, our estimation strategy has two stages. First, we use the personal characteristics of enlisted personnel to predict civilian earnings on a rating-by-rating basis. Second, we use these predicted earnings, as well as additional information on enlisted personnel, to estimate the relationship between compensation and retention. We use the dichotomous logit model when estimating the determinants of the probability of reenlistment. We also make use of the multinomial logit model, however, and are able to simultaneously estimate the determinants of both the reenlistment decision and the decision to extend one's enlistment.

We use two primary sources of data when examining the relationship between relative compensation and enlisted retention. The first is the EMR, which we use to provide information on zone A reenlistment decisions and the demographic characteristics of the enlisted members who make these decisions. The second source of data, the March Current Population Surveys (CPS), provides information on civilian earnings opportunities.

Findings

Our results suggest that the amount of variation in civilian earnings opportunities from one rating to the next is substantial. Consistent with expectations, we find that those in highly technical ratings command the highest civilian salaries. Furthermore, these ratings currently have the most severe manning problems.

Although highly technical ratings have the greatest civilian opportunities, we find that they also have the highest levels of military compensation. A comparison of earnings in these ratings relative to nontechnical ratings with the differentials found in the civilian sector, however, suggests that occupational differentials are substantially smaller in the military.

Our empirical results also imply a positive and statistically significant relationship between the level of military compensation and the proportion of eligible personnel who reenlist. Specifically, we estimate that a one-level increase in selective reenlistment bonuses raises reenlistment by about 2 percentage points.

Implications and recommendations

Our analysis demonstrates that, in general, ratings with the most significant manning shortfalls have the largest civilian earnings opportunities. Although this is consistent with many preconceptions, it is less well known that these ratings also have the highest levels of military compensation. The existence of manning problems, despite high levels of compensation by the military, does *not* imply that compensation is an ineffective tool to attract and retain personnel. On the contrary, our estimates of the relationship between changes in compensation and reenlistment propensities suggest a direct link between pay and the decision to remain in the Navy.

Our analysis, then, implies that current levels of compensation are *not sufficient* to address the manning problems faced by many technical ratings. In other words, greater flexibility in military compensation would help to alleviate manning shortfalls. Therefore, we recommend that the Navy increase compensation for individuals in these ratings to increase retention of these personnel and to correct the manning problems in these ratings.

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Introduction

The military "pay gap" is an issue of concern to many military personnel. Some have approached this issue purely from an equity standpoint, arguing that the military should, out of fairness, pay its personnel a salary comparable to that of those in the private sector. Others fear that a civilian-military wage differential will quickly lead to retention and recruiting problems for the military.

A recent study by the Congressional Budget Office (CBO) [1] takes a close look at the pay gap and offers several suggestions for its use in policy formulation. The CBO argues that, given the differences between military and civilian work/life, differences in military and civilian pay will not necessarily lead to manning problems in the military. For example, if individuals require higher military pay to compensate them for the nature of military life, differences between military and civilian pay would be *necessary* to reach enlistment goals.

Instead, the CBO suggests that a more effective policy instrument for evaluating adjustments in military pay would be the recruiting and retention patterns of its personnel. For example, low retention is a signal that military compensation should be raised to entice personnel to remain in the military. Similarly, chronically low enlistment levels indicate that many feel that military pay inadequately compensates them for accepting a position in the military.[1] The argument, then, is not that the pay gap should be ignored, but that it should not be the only statistic on which policy-makers should focus.

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1. Compensation is not the only factor on which individuals base their enlistment/reenlistment decisions. Although such factors as quality of life also affect these decisions, previous research has demonstrated strong correlations between changes in compensation and changes in enlistment/reenlistment behavior (for a summary of the retention literature, see [2]). Compensation, therefore, can be a powerful recruiting and retention tool for policy-makers to use.

Furthermore, an aggregate civilian-military wage differential can mask significant variation in relative civilian opportunities across occupations. The Navy primarily compensates its personnel based on rank and length of service, whereas the civilian sector offers substantially different wages to workers in different occupations.[2] This implies that the pay gap will be relatively larger in some occupations than in others. A compensation policy that pays its personnel relative to their next best opportunity (i.e., the wage that an individual could earn working in a similar occupation in the private sector) would help to ensure that military compensation remains competitive with civilian opportunities. A joint examination of the civilian-military wage differential and recruiting/retention patterns on an occupation-by-occupation basis, then, is a better way to assess whether compensation is "too low."

This strategy is consistent with the conclusions of an earlier CNA study [5], which argued that the most "direct method" of establishing appropriate levels of compensation "is to observe whether the Navy has a retention problem in an area, and then to link the retention problem to evidence concerning alternative civilian income." If those occupations with the largest pay differentials are also those with the most serious manpower shortages, a closer alignment of military and civilian compensation on an occupation-by-occupation basis could help to alleviate manning shortfalls.

The approach taken in this paper is to examine the correlation between manning shortfalls in various Navy enlisted ratings and the relative earnings of enlisted personnel in these occupations. We also examine differences in military compensation from one rating to another and compare these differentials with those in the civilian sector. In addition, we examine the relationship between military compensation and the propensity to reenlist, using our new measure of occupation-specific relative military compensation. This analysis yields estimates of the responsiveness of reenlistment rates to changes in relative pay, which, in principle, can be used to estimate the change

2. For an examination of these differences across occupations in the civilian sector, see [3] and [4].

in compensation necessary to achieve manning level targets on a rating-by-rating basis.

Our results suggest that the amount of variation in civilian earnings opportunities from one rating to the next is substantial, with those in highly technical ratings commanding the highest civilian salaries. Furthermore, these ratings currently have the most severe manning problems. Although highly technical ratings have the greatest civilian opportunities, they also have the highest levels of military compensation. A comparison of earnings in these ratings relative to nontechnical ratings with the differentials found in the civilian sector, however, suggests that occupational differentials are substantially smaller in the military. The empirical results also imply a positive and statistically significant relationship between the level of military compensation and the proportion of eligible personnel who reenlist. Specifically, we estimate that a one-level increase in selective reenlistment bonuses raises reenlistment by about 2 percentage points.

This research memorandum begins with a discussion of the identification of recruiting and retention "problems" in Navy enlisted ratings. The next section identifies ratings on which we focus, as well as the process of matching comparable civilian occupations to these ratings. Following this discussion, we identify ratings with enlisted manning shortfalls to assess the degree to which these ratings are suffering from recruiting or retention problems. The fourth section examines civilian opportunities for individuals in these ratings, and compares these earnings opportunities to the level of compensation earned in the military. Section five presents an analysis of the relationship between military compensation and enlisted retention, using both military and civilian data, as well as an occupation-specific measure of civilian earnings opportunities. The sixth section uses the general conclusions from our estimation to suggest how changes in military pay could be used to alleviate current rating-specific manning shortages. The final section presents our conclusions and policy implications.

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Recruiting and retention "problems"

Background

To determine whether low compensation is responsible for recruiting and retention problems in the Navy, it is first necessary to establish what constitutes a so-called manning problem. Although Navy personnel planners have a good feel for current problem areas, it isn't possible to go back in time and establish clear metrics using available data.[3] Each fiscal year, the Navy sets explicit recruiting and retention goals—not at the rating level, but rather as objectives that apply to the Navy as a whole. Although it is reasonable to assume that higher rates of retention are "better," for example, it is not clear what constitutes a "low" retention rate, or how low is "too low."

There are also a few reasons to expect that attracting and retaining personnel is more important in some ratings than in others. For example, the costs associated with training enlisted personnel vary widely from one rating to the next. A recent CNA study [6] calculated the average variable cost associated with training in each Navy enlisted rating. These calculations reveal tremendous variation in training costs. Of the ratings for which training costs are calculated, the average cost is about $12,400 per enlisted member (measured in FY96 dollars).[4] One-quarter of these ratings, however, had training costs below $5,500; another quarter had costs greater than $16,000. The cost to train a Ship's Serviceman (SH) was measured at $2,768, whereas the training costs for the Electronics Technician – Nuclear Field (ET-NF) rating were estimated at $46,720.

3. For example, no records are kept of which ratings experienced what problems at different points in time.

4. For a few ratings, no training costs are available. See [6] for details.

Clearly, the training costs in a rating vary widely across ratings. The opportunity cost of retaining enlisted personnel, therefore, is significantly different across ratings because trained and experienced individuals who separate from the Navy must be replaced and new recruits trained at additional cost. As DoD seeks to control expenditures and maximize productivity, retention in certain specialities with relatively high training costs is critical.

Manning levels by rating

An examination of training costs, however, is not sufficient to establish which ratings are experiencing recruiting and retention problems. Rather, these opportunity costs of low retention identify ratings for which retention problems would be relatively costly. For example, if all billets for a particular rating are filled, one would be hard-pressed to claim that there was any problem.

Yet, if the Navy is having difficulty filling billets for a particular rating, this may be an indication that the Navy is having difficulty either recruiting into or retaining enlisted members in this rating. Clearly, the actual manning levels for each rating must be used to identify those ratings that actually are having problems with recruiting and retention. Such an analysis cannot reveal whether recruiting or retention is "responsible" for manning shortfalls. It can only indicate that a problem exists at some point in the manning process.

Our strategy for identifying manning problems is to examine, on a rating-by-rating basis, the proportion of authorized, active-duty billets that are filled. This examination of manning levels allows us to assess the degree to which ratings are undermanned, if at all, and how these manning levels have changed over time. If a rating is significantly undermanned (i.e., the proportion of billets that are filled is low), we assume that this reflects difficulties either recruiting people into or retaining personnel in this rating.

In this analysis of manning levels, we focus on differences across ratings, as well as on changes over time, and *not* on the actual level of this measure. The argument is that ratings with a lower proportion of billets filled have worse manning problems than ratings with a higher

proportion filled, not that a rating is undermanned or overmanned. This approach implicitly assumes that any "imperfections" in our measure of manning levels are similar across ratings and over time.

It is important to note that the Navy's policy of promoting individuals to fill vacancies makes it more difficult to establish a clean relationship between manning levels and manpower problems. For example, if there is a shortage of E-4s in a particular rating (i.e., low manning of E-4 billets), advancement rates are typically accelerated to fill those billets. This increase in the rate of advancement would increase manning levels, and an analysis of E-4 manning levels might not indicate a problem.

Faster promotion, however, would increase average compensation in this rating, given the fact that basic pay increases with rank. This would tend to remove any correlation between manning levels and civilian-military wage differentials. The existence, then, of a relationship between relative compensation and manning levels *despite* these efforts to eliminate shortfalls provides an even more compelling argument for the case that these ratings have manning problems.

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Enlisted ratings and civilian occupations

Selection of ratings

Two primary considerations influence the selection of ratings on which to focus our analysis. First, we select ratings that are considered technical fields, in terms of the skills typically used by enlisted personnel. This focus reflects the concerns of many in the Navy that it is the technical ratings that are having the largest retention and recruiting problems as a result of relatively high civilian pay. We examine this belief in our analysis of manning shortfalls within enlisted ratings (the next main section).

For comparison purposes, however, we also include some large, nontechnical ratings in our analysis. It is generally believed that these ratings are not having the manpower difficulties present in the more technical ratings. The inclusion of these nontechnical ratings, however, increases the variation in our sample and allows us to obtain more precise estimates. Furthermore, this allows us to compare and contrast the retention/manning experiences of technical and nontechnical ratings.

Second, because rating-specific compensation lies at the centerpiece of the analysis, we choose ratings that have clear civilian counterparts. A related constraint is that these civilian occupations be relatively large. This eliminates such ratings as AC (Air Traffic Controllers) that, while having a clear civilian counterpart, have too few workers in the civilian data to obtain reliable earnings estimates. Next we discuss the process of matching enlisted ratings with comparable civilian occupations.

Selection of comparable civilian occupations

Crucial to this analysis is a reliable estimate of the civilian opportunities of Navy enlisted personnel. The bulk of previous empirical research has taken one of two approaches in the treatment of civilian wages in recruiting and retention models. The first approach uses estimates of veterans' actual earnings outcomes upon leaving the military.[5] The occupation in which one worked while in the military is typically controlled for in the estimation, but these earnings estimates are averages across all civilian occupations in which these veterans are employed.

This strategy suffers from two shortcomings. First, those who opt to leave the military (i.e., the veterans for whom civilian earnings are calculated) are likely the people with the *best* relative civilian opportunities. Therefore, estimates of veterans' civilian earnings likely *overstate* the earnings opportunities for the average enlisted person. Also, the use of veterans' earnings implicitly assumes that the opportunities available to those currently enlisted are the same, on average, as those available to veterans at the time they entered the civilian labor force. To the extent that civilian labor market opportunities differ over time, either from a change in the economic environment or in the composition of the pool of enlisted personnel, these earnings estimates are not reliable proxies for the civilian opportunities of current enlisted personnel.

The second treatment of civilian wages in recruiting and retention models is to use an estimate of the average earnings of civilians at the time of the enlistment/reenlistment decision.[6] A person's rating is typically controlled for in the estimation of the retention model, whereas the military-civilian wage ratio is an average across all occupations. The responsiveness of retention to changes in pay from these models, then, can be interpreted as the average responsiveness to a

5. For examples, see [7].

6. CNA has used this approach extensively in recent work on retention; for examples, see [8] and [9]. Reference [10], using monthly data in an enlistment model, estimates civilian earnings with a 4-month lead.

change in pay across all ratings. Given that the focus of this previous work was not on pay, this was an acceptable approach to controlling for civilian wage opportunities; however, it is too general for a direct examination of the links between pay and reenlistment.

The approach taken in this research memorandum is more direct in its comparison of military and civilian earnings. The earnings of enlisted personnel within a rating are directly compared to the earnings of civilians in occupations that are comparable to the Navy rating.[7] This strategy, though conceptually straightforward, is not without problems. To yield reliable results, this approach requires an accurate matching of Navy enlisted ratings to civilian occupations. Some ratings have clear civilian counterparts (e.g., Air Traffic Controller), but many ratings do not (e.g., Torpedoman).

Matching Navy ratings to civilian occupations, however, is facilitated by information from two different data sources. First, the Defense Manpower Data Center (DMDC) has constructed a "crosswalk" that links most ratings to a 5-digit Occupational Employment Statistics (OES) code used to classify civilian occupations. This occupational coding is more detailed than that found in the Current Population Surveys (CPS) data, our source for information on civilian earnings. However, the written descriptions of most OES codes are identical to those used in the CPS, which allows us to match enlisted ratings to civilian occupations.

Although DMDC matches many ratings to a unique civilian counterpart, some ratings are matched to more than one civilian occupation. The problem with relying exclusively on the DMDC crosswalk is that no distinction is made between tasks and duties that are performed sporadically by enlisted personnel and those on which the person spends the majority of his or her time. Rather, the crosswalk matches the enlisted rating to a civilian occupation for *each* of the general categories of duties that an enlisted member is expected to perform. To

7. This approach has been used on a limited basis, typically matching one or two ratings with civilian occupations. The most notable example is CNA's work on retention of Navy physicians [11]. Reference [12] has occupation-specific data for bonuses, but not for civilian earnings.

match ratings to those civilian occupations that resemble the tasks most common to enlisted members, we use an additional data source.

The Occupational Conversion Index [13] provides a comprehensive matching of both enlisted and officer occupations with their civilian counterparts. In contributing to this volume, the Navy has classified each of its occupations, defined by both rating and Navy Enlisted Classification (NEC), according to a general DoD taxonomy. The advantage of classification by both rating and NEC is that substantively different duties performed by individuals within a rating can be classified as different occupations, and can be matched to different civilian occupations.[8]

Table 1 presents a listing and description of the enlisted ratings on which our analysis focuses, as well as a description of the civilian occupation(s) to which each is matched.[9]

It is useful to compare these civilian occupation matches with those made in previous research. Reference [14] assembled a panel of Navy officers and Navy Military Personnel Command (NMPC) occupational classification experts in the early 1980s to match civilian occupations to Navy enlisted ratings.[10] Despite the fact that these matches were made in the early 1980s, and given the evolution of tasks and skills associated with each rating, our choices of civilian occupations are very similar to those matched in [14].

8. Some ratings are not listed in the DMDC database. If they are listed in the Occupational Conversion Index, these ratings are also matched to civilian occupations with similar duties.

9. The appendix contains a complete listing of the matches of ratings and civilian occupations, including the 3-digit classification used by the CPS.

10. See tables B-1 and B-2 in [14].

Table 1. Enlisted ratings and comparable civilian occupations

Rating	Description	Civilian occupations
AD	Aviation Machinist's Mate	Aircraft Engine Mechanics
AK	Aviation Storekeeper	Material Recording, Scheduling, and Distributing Clerks
AT[a]	Aviation Electronics Technician	Electrical and Electronic Engineers; Data Processing Equipment Repairers
AZ	Aviation Maintenance Administration	Records Processing Occupations, Except Financial
CTM	Cryptologic Technician - Maintenance	Electrical / Electronic Equipment Repairers
EM	Electrician's Mate	Electrical / Electronic Equipment Repairers
ET[a]	Electronics Technician	Electrical and Electronic Engineers; Data Processing Equipment Repairers
FC[a]	Fire Control Technician	Electrical and Electronic Engineers; Data Processing Equipment Repairers
GSE	Gas Turbine Systems Technician - Electrician	Electrical and Electronic Engineers; Plant and System Operators
GSM	Gas Turbine Systems Technician - Mechanical	Industrial Machinery Repairers and Machinery Maintenance Occupations; Plant and System Operators
MM	Machinist's Mate	Industrial Machinery Repairers and Machinery Maintenance Occupations
MS	Mess Management Specialist	Food Service Occupations
SH	Ship's Serviceman	Sales Workers, Retail and Personal Services
SK	Storekeeper	Material Recording, Scheduling, and Distributing Clerks
YN	Yeoman	Secretaries, Stenographers, and Typists

a. The civilian occupations to which this rating is matched vary by NEC; see the appendix for details.

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Manning levels of Navy enlisted ratings

Given this set of ratings on which our analysis focuses, we now identify which ratings have manning problems. We also explore whether these are chronic manning shortages, or whether manning levels of these ratings have fallen over time.

Our data on the number of individuals and the number of authorized billets in these ratings come from the Enlisted Master Record data (EMR) and from CNA's billet file, which is an extract from the Total Force Manpower Management System (TFMMS) data. These data are available separately for each rating and paygrade, as well as for sea and shore duty. Over the FY91-99 period, there are, on average, about 145,000 enlisted members per year for the ratings on which we focus, and about 146,000 authorized billets per year.

We focus on the proportion of authorized billets filled for paygrades E-4 through E-6 to establish a link between this measure of manning shortfalls and zone A reenlistment decisions. The decision to reenlist in zone A has direct implications for the number of E4-E6 billets that are, and will be, filled. For example, if fewer people choose to reenlist, one would expect the proportion of billets filled to decline because fewer people are entering these paygrades.[11]

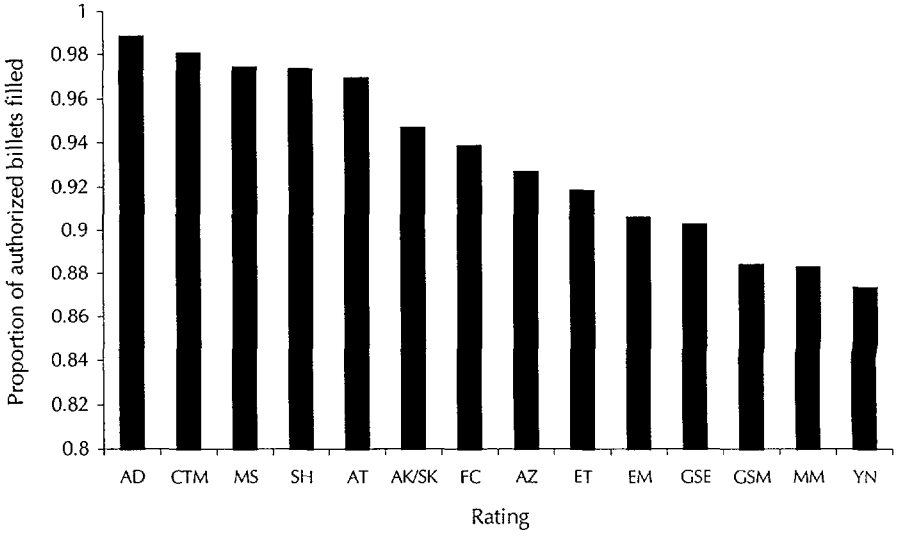
Average manning levels for FY91-99

Figure 1 displays average manning levels of E4-E6 billets over the FY91-99 period, calculated separately for each rating. Some ratings have relatively high manning levels, on average, over this period (e.g., AD, CTM), but some have low manning (e.g., GSM, MM, YN). This percentage of all billets filled can reflect widely different manning

11. The proportion of billets filled also depends on both retention in these paygrades and promotion rates for those currently in these paygrades.

levels for sea and shore billets.[12] Some ratings have significantly low manning levels at sea and high manning levels at shore (e.g., FC, SH). Other ratings exhibit the opposite pattern—well-manned at sea with substantial shortfalls at shore (e.g., AT, CTM).

Figure 1. Average manning levels[a]



a. Average manning levels of E4-E6 billets over the FY91-99 period.

In some instances, these averages over a 9-year time frame mask worsening trends in manning levels over time. Though the average proportion of billets filled over a 9-year period might not be particularly low, a significant decline in manning levels is an indication that the Navy's success in retaining and/or recruiting individuals for a given rating has deteriorated over time.

12. For this analysis, shore duty is identified as "type 1" duty and sea duty as "type 2."

Trends in two ratings

For example, figure 2 displays trends in the proportion of Aviation Electronics Technician (AT) billets filled over the FY91-99 period. For this rating, even though manning levels for E4-E6s were relatively high in the early 1990s, only 87 percent of these billets were filled by FY99. This significant decline was largely driven by a decline in the percentage of shore billets filled, but there were also sizable declines in manning of sea billets in this rating.

Figure 2. Manning levels—Aviation Electronics Technicians (AT)[a]

a. Manning levels of E4-E6 billets.

Note that the military drawdown began in FY92 and continued through FY95. If the number of authorized billets remained stable over this period, one would expect a decrease in our measure of manning shortfalls over this period due to the downsizing of the Navy. For the AT rating, however, the proportion of billets filled continued to decline after the drawdown, which suggests that this rating faced worsening manning shortfalls over this period.

Similarly, figure 3 displays E4-E6 manning levels for Cryptologic Technician - Maintenance (CTM) billets over this same time period. This rating also experienced significant declines in manning levels over the FY91-99 period. By FY99, only 90 percent of its billets were filled. This trend reflects significant declines in manning in both sea and shore billets.

Figure 3. Manning levels—Cryptologic Technicians - Maintenance (CTM)[a]

a. Manning levels of E4-E6 billets.

We can classify a rating as having a so-called manning problem, then, not only if manning levels are chronically low, but also if these levels are significantly falling. Specifically, we identify a rating as having a problem with retention and/or recruiting if it exhibits at least one of three characteristics:

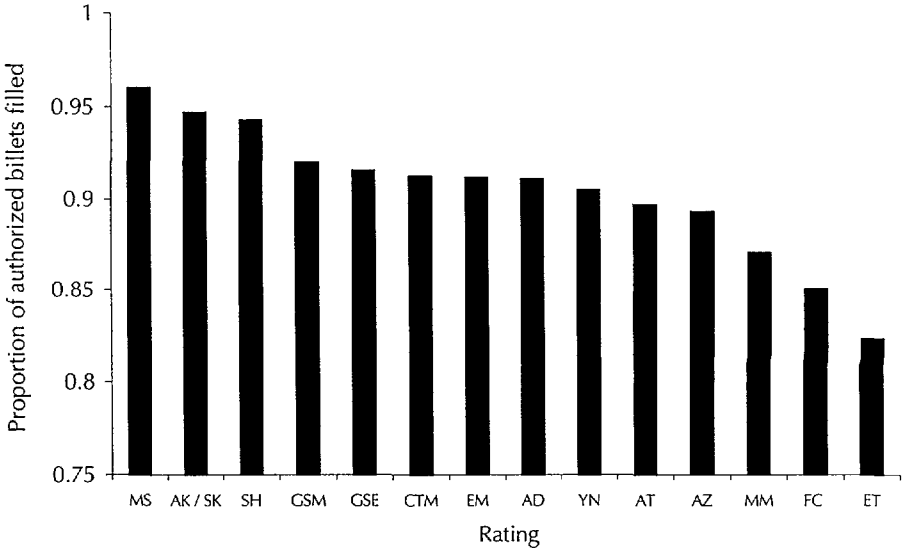
1. Low (less than 90 percent) average manning levels at sea (AZ, EM, ET, GSE, GSM, MM, SH)
2. Low average manning levels at shore (YN)
3. A negative and statistically significant trend in overall manning levels over the FY91-99 period (AD, AT, CTM, FC).

Note that most ratings on which we focus have some sort of manning problem; only the AK, MS, and SK ratings have consistently high manning levels over the FY91-99 period.

Manning levels in FY 98

An alternative approach is to consider manning levels at a specific point in time, rather than look at averages over a period of time. As a comparison, figure 4 displays manning levels for these ratings in FY98.[13] A comparison of these levels with those in figure 1 reveals that some ratings have more severe problems when looking at recent data instead of averages over time. For example, although manning levels are about average for the ET and FC ratings over the entire FY91-99 period, these ratings have the worst manning problems in FY98.

Figure 4. FY98 manning levels[a]



a. Manning levels of E4-E6 billets.

13. 1998 is the most recent year for which we have civilian data.

Ratings identified by DoD as "retention critical"

We also compare these results with the ratings that the Navy believes suffer from problems with retaining enlisted personnel. A recent briefing report from the United States General Accounting Office (GAO) [15] looked explicitly at the perspectives of people in "retention critical specialties." According to the GAO report, these specialties were ratings that "DoD believed were experiencing retention problems." The advantage of looking at ratings identified by DoD is that, even though rating-specific recruiting and retention goals are not explicitly set, the Navy probably has a good sense of where significant problems lie. For the Navy, DoD identified the ratings listed in table 2 as "retention critical" for enlisted personnel.

Table 2. "Retention critical" ratings for enlisted personnel

Rating	In sample	Description
AMS		Aviation Structural Mechanic -- Structures
AO		Aviation Ordnanceman
CTR		Cryptologic Technician -- Collection
ET	x	Electronics Technician
FC	x	Fire Control Technician
HM		Hospital Corpsman
IM		Instrumentman
MM	x	Machinist's Mate
OS		Operations Specialist
RM		Radioman
YN	x	Yeoman

Of the eleven ratings in table 2, only four (ET, FC, MM, YN) are in the set of ratings we chose to study, and we do identify all four as having manning problems over the FY91-99 period. The other seven ratings identified by DoD were excluded from our analysis for various reasons.[14]

14. Most of these ratings do not have clear civilian counterparts (AO, CTR, OS), have too few enlisted members in our data (IM), or have too few comparable civilians in our civilian data for us to analyze (AMS). The RM rating was excluded because of its merge with the DP and DS ratings; HMs are health care specialists, which are substantively different from other enlisted personnel.

Civilian and military earnings opportunities by rating

Given our matching of various Navy enlisted ratings with comparable civilian occupations, we can begin to analyze the earnings opportunities of enlisted members in the civilian sector. This section presents an analysis of average civilian earnings by rating, and examines the relationship between civilian earnings opportunities and enlisted manning shortfalls. We also compare military compensation with manning levels in these ratings.

Civilian earnings opportunities

Figure 5 presents data on the earnings opportunities available to enlisted personnel in the ratings selected for this analysis.[15] Ratings are ranked by median annual income earned by those in comparable civilian occupations. Civilian earnings are calculated using the 1992-1999 March CPS, for full-time, full-year workers, ages 18 to 30, with some college education or less.[16]

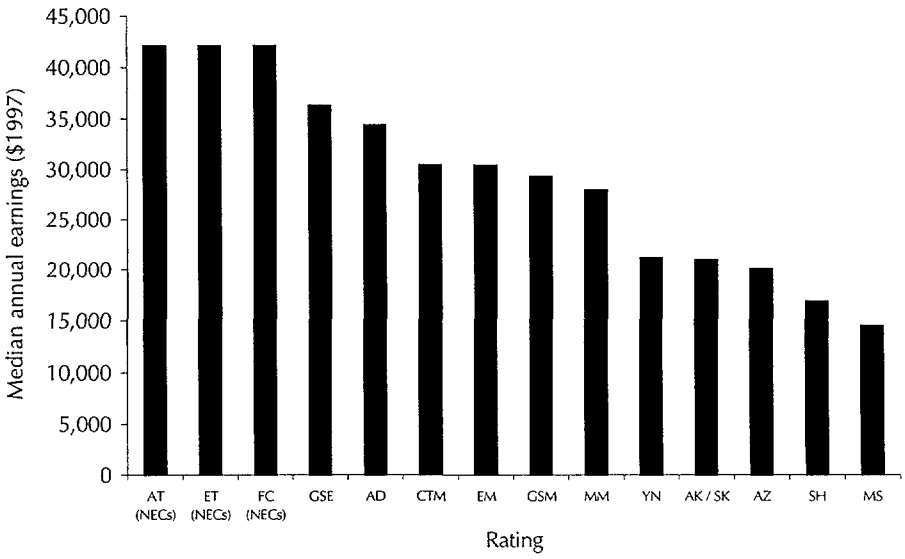
In general, the magnitude of average earnings in comparable civilian occupations is consistent with expectations. Ratings requiring more technical skills have civilian counterparts with higher annual earnings than less technical ratings. Furthermore, civilian earnings opportunities vary substantially from rating to rating. For example, earnings in comparable civilian occupations are more than $40,000 per year for

15. For the ratings for which comparable civilian occupations vary by NEC (AT, ET, FC), earnings opportunities are displayed for those with rating-specific NECs. The majority of enlisted personnel in these ratings hold at least one rating-specific NEC.

16. The 1992-1999 March CPS provides earnings information for 1991 through 1998.

the highly technical ratings (AT, ET, FC), whereas average earnings are less than half that amount for those in nontechnical ratings (MS, SH). This sizable variation justifies an analysis of the relationship between compensation and reenlistment using occupation-specific estimates of civilian earnings opportunities.

Figure 5. Earnings in comparable civilian occupations—1991-1998[a]



a. Annual earnings of 18- to 30-year-old full-time workers without a college degree in 1991-1998.

An examination of figure 5 indicates a strong relationship between ratings with manning shortfalls and the level of earnings found in comparable civilian occupations. In fact, the ratings with the highest civilian earnings opportunities (AT, ET, and FC) all have manning problems in FY98; indeed, the ET and FC ratings have the largest manning shortfalls of all the ratings considered in this study.

A few ratings (AZ and MM) have manning problems in FY98 despite relatively low civilian earnings opportunities. When considering average manning levels over FY91-99, more examples are available. For instance, even though Ship's Servicemen (SH) have relatively low civilian earnings, manning of these billets is chronically low.

This does not imply, however, that civilian earnings are irrelevant in terms of the adequacy of military compensation. Other potential contributors to manning shortfalls include unexecutable billet structures, incorrect requirements, imbalances during the drawdown, and historical inventories. Rather, this analysis underscores the notion that measures of the pay gap are not sufficient in determining whether military compensation is "too high" or "too low."

Differences in military compensation by rating

While military personnel are primarily compensated by rank and length of service, occupational earnings do exist. Differences in earnings across occupations mainly result from selective reenlistment bonuses (SRBs) and differences in advancement rates.

Selective Reenlistment Bonuses (SRBs)

The availability of SRBs for certain skills in the Navy is the most well-known source of variation in military compensation across occupations. Navy planners set different SRBs for different skills by assigning each rating and NEC an SRB multiplier (possibly zero). The amount of the SRB is computed by multiplying a person's monthly basic pay at the time of reenlistment by the number of years of additional obligated service, and then multiplying this amount by the SRB multiplier.[17] Higher SRB multipliers, then, correspond to higher SRBs.

To the extent that SRB multipliers differ across ratings, compensation of enlisted personnel will also vary from one rating to the next. As the name implies, however, selective reenlistment bonuses are available only to those who choose to reenlist.[18] For individuals in their first term of obligated service, then, SRBs provide no occupational earnings differentials.

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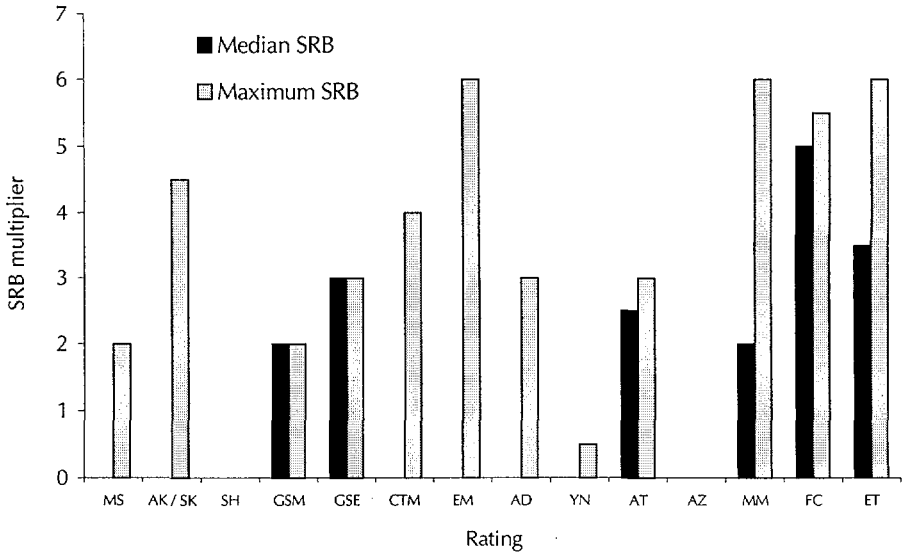
17. Fifty percent of the bonus is paid at the time of the reenlistment decision; the remainder of the bonus is paid out in equal annual installments over the duration of the reenlistment contract.

18. A related constraint is whether the Navy allows a person to reenlist.

Figure 6 presents both the median and maximum SRB level (multiplier) available to reenlistment-eligible individuals in zone A in FY98.[19] Ratings are ranked in descending order by their FY98 manning levels; if the median (maximum) SRB for a rating is zero, no bar is shown. A comparison of median (maximum) SRB levels from one rating to the next suggests that there is a fair amount of variation in SRB amounts across occupations.

Figure 6. FY98 SRB multipliers[a]



a. FY98 median and maximum zone A SRB multipliers.

From figure 6, we see that ratings with the largest manning shortfalls in FY98 have some of the highest SRB levels.[20] In particular, both the ET and FC ratings have not only high median SRBs, but also a significant number of personnel eligible to receive the maximum

19. Zone A is defined as between the first 21 months and 6 years of active duty service.

20. The proportion of authorized billets filled is measured at the end of the fiscal year, whereas SRB multipliers for the fiscal year are set at or *near* the beginning of the fiscal year.

authorized SRB. The existence of high SRBs for ratings with relatively large manning shortfalls suggests that the Navy has a good sense of which ratings have severe manning shortages and that efforts are being made to alleviate these shortfalls through the provision of monetary incentives.

There are also ratings with high SRBs whose manning shortfalls are not as severe (for example, GSE). This does not imply that these SRBs are "too high"; rather, it is consistent with the notion that SRBs have been successful in retaining people in these ratings.

Advancement opportunities

In addition to the availability of selective reenlistment bonuses, military compensation can vary across occupations to the extent that promotion opportunities and advancement rates differ from one rating to the next. Basic pay is completely determined by rank and length of service, so two people with equal amounts of time in the Navy receive different basic pay only if they are in different paygrades (ranks).

Figure 7 presents an example of these different advancement rates. For each rating, the figure shows the distribution across paygrades for individuals at 45 months of service in FY98.[21] For each rating, it gives the proportion of enlisted personnel who are E-2s, E-3s, E-4s, and E-5s; these categories sum to 100 percent. Again, ratings are listed in descending order by their FY98 manning levels.[22]

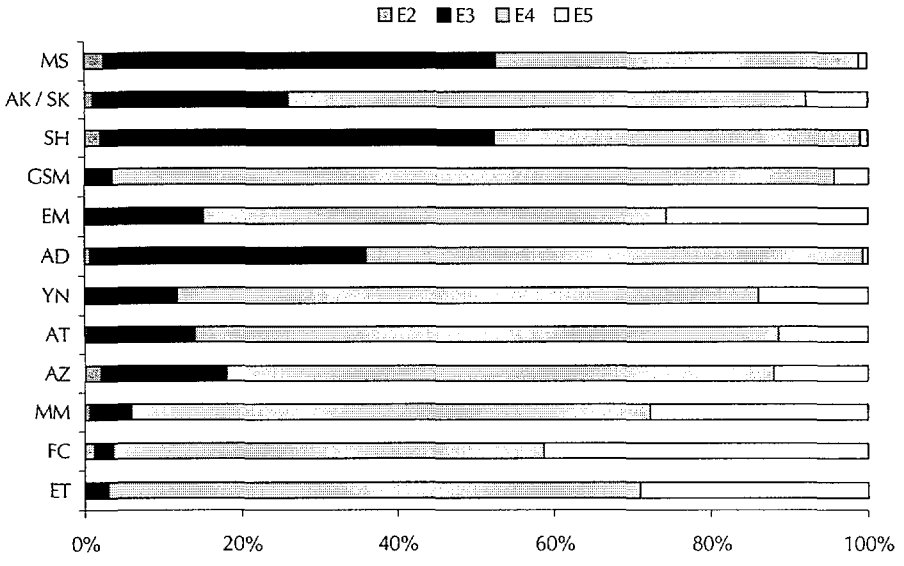
As figure 7 demonstrates, variation in advancement rates across occupations is significant. For example, 53 percent of MSs and 52 percent of SHs are still E-3s or below at 45 months of service, whereas less than 4 percent of FCs are still E-3s or below. Similarly, virtually no personnel

21. Differences in reenlistment eligibility and reenlistment rates across ratings create a "selection effect" that can distort the paygrade distribution. Since most individuals are initially obligated for 4 years of active duty service, a cross-sectional comparison at 45 months is presented. Measuring differences in advancement at 33 months, however, yields similar conclusions.

22. The CTM and GSE ratings have too few individuals at exactly 45 months of service in the data to calculate a distribution.

in the MS or SH ratings have attained E-5 by 45 months, yet over 40 percent of FCs and 30 percent of ETs have reached E-5 by this point in their Navy careers.

Figure 7. Distribution of individuals across paygrades—FY98[a]



a. Individuals with 45 months of active duty service.

In general, ratings with the largest manning shortfalls in FY98 are also those with the highest concentration of enlisted personnel in higher paygrades. Though this is certainly not a monotonic relationship, it does provide evidence that enlisted ratings with significant manning shortages offer some of the highest levels of military compensation among the ratings on which we focus.[23]

23. In the case of advancement rates, one could argue that there is a *causal* relationship between these two outcomes. If manning shortages necessitate an accelerated promotion time table to fill key billets, manning shortfalls could be partially causing faster advancement and, simultaneously, relatively higher military compensation in these ratings.

Comparisons of military and civilian earnings opportunities

Our analysis of the earnings opportunities of enlisted personnel suggests that, although ratings with the largest manning shortfalls typically have the strongest civilian opportunities, they also typically have the highest levels of military compensation. This is consistent with the belief that Navy planners have a good idea as to which ratings are experiencing manning problems and take action to alleviate these problems.

In the remainder of this paper, we attempt to establish a link between *relative* military compensation (a measure of military compensation relative to civilian earnings opportunities) and manning shortfalls in two ways. First, we estimate an empirical relationship between relative military compensation and the propensity to reenlist on a rating-by-rating basis. The positive effect of increases in military compensation on reenlistment behavior confirms that compensation can be used as a tool by Navy planners to alleviate manning shortfalls.

Second, we compare differences in earnings across occupations in both the military and civilian sectors and document the relationship between these differentials and observed manning shortfalls. Despite differences across occupations in military compensation, our analysis suggests both that these differentials are not as large as in the civilian sector and that the magnitude of these differences is directly correlated with manning shortfalls in these enlisted ratings.

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Military compensation and enlisted retention

Data

We use two major sources of data when examining the relationship between relative compensation and enlisted retention. The first is CNA's holdings of the Navy's Enlisted Master Record (EMR) data, which we use to provide information on reenlistment decisions and the demographic characteristics of the enlisted members who make these decisions. The second source of data, the March Current Population Surveys (CPS), is used to provide information on civilian earnings opportunities.

Our estimation strategy has two stages. First, we use the personal characteristics of enlisted personnel to predict civilian earnings on a rating-by-rating basis. Second, we use these predicted earnings, as well as additional information on enlisted personnel, to estimate the relationship between compensation and retention.

Reenlistment data

Measuring reenlistment and retention

Unfortunately, there is no clear consensus on the appropriate measure of "reenlistment" or "retention" in the empirical literature. Furthermore, prior research has not always explicitly described the sample used to produce estimates. Because these estimates are, in principle, very sensitive to the choice of sample, we feel the need to carefully explain the composition of our sample and the rationale for our sample selection.

An important feature of our sample is that we focus on individuals who are *eligible* to reenlist.[24] This reflects our desire to focus on those for whom a choice to reenlist is actually available. Our implicit

24. Most CNA research has focused exclusively on individuals eligible to reenlist.

assumption is that eligibility status is determined by the Navy and not deliberately influenced by the individual.[25]

If an individual actually reenlists, we assume that the person was eligible to reenlist. If an individual separates from the Navy, the EMR contains a reenlistment quality code that distinguishes "eligible losses" (i.e., individuals eligible to reenlist who choose to leave the Navy) from "ineligible losses" (i.e., individuals who leave the Navy and were not eligible to reenlist). Our sample contains eligible losses, but excludes ineligible losses. Finally, there are individuals who neither separate nor formally reenlist, but opt for long-term extensions of their contracts.[26] Because these individuals are eligible to reenlist, they are present in our sample as well.[27]

The key variable of interest, then, is whether these eligible individuals choose to leave the Navy, sign reenlistment contracts, or opt for long-term extensions of their contracts. We define the "reenlistment rate" as the proportion of those eligible to reenlist who actually reenlist.[28] The "retention rate" is the proportion of those eligible to reenlist who remain in the Navy, whether through reenlistment or a long-term extension.

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25. Reference [16] is one of the few to explicitly consider the issue of reenlistment eligibility. It argues that eligibility is endogenous, given that many of the reasons for ineligibility in the data can conceivably be influenced by the individual. However, they also present alternative estimates based on a sample of individuals that are eligible to reenlist. Their estimates of the pay elasticity of reenlistment are smaller when restricting the sample to those classified as eligible to reenlist.

26. Long-term extensions are between 2 and 4 years of additional service.

27. As discussed in [2], some researchers have excluded long-term extensions altogether. Our estimates are not sensitive to the inclusion of long-term extensions in our sample.

28. Those who extend are in the denominator, but not the numerator, of our reenlistment rate because they technically do not reenlist. Furthermore, the bulk of those who extend are not eligible for SRBs. We explicitly test, however, whether there is a difference in the effect of pay on the propensities to reenlist and extend, and conclude that there is a substantial difference.

Sample selection

For FY89 to FY98, we extract EMR records for enlisted members in zone A at the time they make reenlistment decisions. Table 3 displays zone A reenlistment and retention rates in FY98 for each rating on which we focus. Ratings are sorted by their reenlistment rate for FY98.

Table 3. Zone A reenlistment and retention rates by rating—FY98

Rating	Eligible population	Reenlistment rate	Retention rate
FC	352	0.582	0.645
YN	739	0.505	0.606
MS	680	0.457	0.521
ET	625	0.451	0.501
AZ	245	0.429	0.502
CTM	67	0.403	0.493
AK / SK	848	0.396	0.468
AD	458	0.365	0.421
MM	1,106	0.364	0.375
AT	965	0.360	0.367
GSE	73	0.343	0.370
GSM	315	0.340	0.352
EM	506	0.267	0.302
SH	291	0.258	0.361

As this table shows, reenlistment (retention) rates vary significantly from one rating to the next. Furthermore, there is no clear relationship between the rate of reenlistment and the technical skills associated with a rating. For example, while FCs have a relatively high reenlistment rate, ATs have a relatively low reenlistment rate. Clearly, a multivariate analysis is needed to examine the determinants of reenlistment decisions.

Most of the variables on which we focus are taken from the EMR at the time of the reenlistment decision, although many demographic variables, such as race, are characteristics of the individual that do not

change over time. Table 4 lists the specific variables we use in our analysis.

Table 4. Individual characteristics—EMR

Variable
Personal characteristics
Gender
Race (Hispanic, Black, White, Other)
Age
AFQT
Marital status
Military-specific characteristics
Rating
Length of service
Length of initial enlistment contract
Fiscal year of reenlistment decision
Basic pay at time of reenlistment decision
Current duty status (sea / shore)
SRB level

In considering zone A reenlistment decisions, records are excluded for the following reasons:

1. Paygrade other than 3, 4, 5, or 6 at the end of the first term
2. Rating other than those in table 1
3. Individuals with Nuclear Field NECs.

Military compensation

Because compensation lies at the heart of this analysis, it is important to get reliable estimates of both military and civilian compensation. Detailed information on every single pay received by enlisted members is not available in the EMR. Our approach, therefore, is to capture the major sources of compensation that substantively differ from rating to rating. Our estimate of military compensation includes two primary components: basic pay and reenlistment bonuses.

Although basic pay is completely determined by paygrade and length of service (LOS), it can vary by rating, to the extent that the speed of promotion varies across ratings. Furthermore, basic pay is the largest component of military compensation. We take the monthly amount earned by the enlisted member at the time of the reenlistment decision and multiply it by twelve to get an estimate of annual basic pay.

Second, the most significant way in which compensation varies across ratings is through the payment of selective reenlistment bonuses (SRBs). SRBs are available only to personnel with specific skills, defined by rating and/or Navy Enlisted Classification (NEC). The value of the bonus is calculated by multiplying monthly basic pay, the SRB multiplier, and the length of the reenlistment contract.

We cannot use the actual SRB received in our estimate of military compensation because SRBs are given only to those who choose to reenlist. For those who decide not to reenlist, however, the SRB (if offered) is available and is, therefore, a factor in one's reenlistment decision. Despite the existence of the SRB, however, some choose not to reenlist, and the amount of the bonus they would have received is not available in the personnel records.[29] To proxy the value of the SRB, we enter the SRB multiplier for which an individual is eligible as a separate independent variable in our regressions.[30]

Civilian data

Our estimation strategy for civilian earnings opportunities is more sophisticated than that used in previous studies. For each rating, we extract CPS data from 1983 to 1998 for full-time, full-year workers, ages 18 to 62, who are employed in the occupations to which we have

29. The SRB multiplier and basic pay are known, but it is impossible to know for how many years individuals would choose to reenlist.

30. We do not include the full amount of the bonus for a few reasons. First, SRBs are paid out in installments over the duration of the reenlistment contract, and our measure of compensation is an annual measure. Second, the amount of the SRB depends on the length of reenlistment, which varies across decisions. Alternative specifications, which add the average annual payment of the SRB to our estimate of basic pay in a measure of military compensation, yield similar empirical results.

matched the rating.[31] We then estimate earnings regressions, controlling for year, gender, race, educational attainment, and age. The estimated coefficients allow us to predict, for each rating, the relationship between individual characteristics and civilian earnings.

Finally, we use the estimated relationships from these regressions and the characteristics of enlisted members to predict civilian earnings for those making reenlistment decisions.[32] These variations in civilian earnings opportunities across ratings, across individuals within a rating, and over time allow us to obtain a more precise estimate of the responsiveness of retention decisions to changes in rating-specific compensation.

Our key independent variables, then, are a rating-specific military/civilian pay ratio, computed by dividing our estimate of basic pay by our estimate of civilian earnings, and the SRB level available to an individual making a reenlistment decision. The remainder of this research memorandum concerns estimating the effects of changes in compensation on reenlistment, and the degree to which changes in compensation are needed to eliminate manning shortfalls.

Economic data

To control for economic conditions at the time of the reenlistment decision, we also consider the unemployment rate at the time of the reenlistment decision. We use state-specific, monthly unemployment rates, where the unemployment rate is that of the state in which a person was a resident when first enlisting. To the extent that people are considering job opportunities "back home" when making a reenlistment decision (a reasonable assumption for those in zone A), these local unemployment rates reflect the economic environment in which a person is operating at the time of reenlistment.

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31. The time frame used reflects the years for which we have consistent civilian data on earnings and occupational classification.

32. We do not use the level of educational attainment recorded in the EMR when predicting civilian earnings opportunities because the data do not reflect training received in the Navy. For each rating, civilian earnings are predicted as though one had some college education. Our estimates of the pay elasticity of reenlistment are not sensitive to this assumption.

Results

Model specification

To estimate the effect of military compensation on reenlistment patterns, we make use of a standard logit regression model.[33] Though other, more sophisticated models have sometimes been used in previous studies, the results from the logit model have a relatively straightforward interpretation.

The model presented here, however, is slightly different, in that many of the explanatory variables usually included are *not entered directly in the regression.* Such variables as gender, race, age, and fiscal year are used to estimate the civilian earnings opportunities for enlisted members and, therefore, are not entered separately in the regression equation. Including these variables after using them to estimate civilian earnings would remove a significant amount of the variation in civilian earnings, effectively "undoing" our initial estimation. This would decrease the precision of our estimates of the pay effect on reenlistment. Our approach, then, does not assume that these demographic variables are unimportant. Rather, differences in reenlistment behavior among these demographic groups are implicitly attributed to differences in their civilian opportunities.[34]

Although any trend in reenlistment rates is controlled for in our estimation of civilian earnings, we also include a dummy variable if the reenlistment decision took place between FY92 and FY95. To support the drawdown, the Navy used two programs designed to *encourage* separation: the Voluntary Separation Incentive (VSI) and Special Separation Benefit (SSB) programs.[35] The Navy used these programs

33. For a detailed explanation of the logit model, see [17]. For an example of an empirical application of this model, see [9].

34. This assumption is consistent with many interpretations of regression results in previous studies. For example, [9] attributes a negative relationship between ability and reenlistment to the "stronger civilian opportunities" of high-ability individuals. Our approach controls for differences in civilian earnings due to demographic characteristics.

35. Reference [18] discusses the VSI/SSB programs in greater detail.

mainly from FY92 to FY95, but they are still technically in effect. We control for the use of these programs in our estimation because we feel that their use reflects a period during which the Navy's attitudes toward reenlistment were different from that of the current climate.

Table 5 presents the means (or, where appropriate, the proportion of our sample with each characteristic) of the variables used in our estimation.

Table 5. Descriptive statistics

Variable	Mean
Reenlistment rate	0.400
Retention rate	0.463
Military/civilian pay ratio	0.597
SRB multiplier	1.025
Unemployment rate	7.060
AFQT score	60.00
3YOs[a]	0.101
5YOs[a]	0.013
6YOs[a]	0.292
Married[a]	0.425
FY92-95[a]	0.420
Sea duty[a]	0.708

a. Proportion with this characteristic is presented.

Logit results

Table 6 displays the results from the logit estimation. In this model, the dependent variable indicates whether an individual chooses to reenlist. Because the logit model estimates a nonlinear relationship between the explanatory variables and the probability of reenlistment, the interpretation of the coefficients is not straightforward. To facilitate an interpretation of the results, the "marginal effects" are calculated and presented in the last column.[36] The marginal effect measures the percentage-point increase in the probability of reenlistment, holding all

36. Marginal effects are calculated using the average derivative.

else constant, given a unit change in one of the independent variables. For example, a marginal effect for marital status of 0.15 implies that, for two otherwise identical individuals, the probability of reenlistment is 15 percentage points higher for the married than the single person. With an average reenlistment rate of 33 percent for single enlisted personnel, a 15-percentage-point increase is extremely large.

Table 6. Logit estimates of reenlistment model

Independent variable	Coefficient	Marginal effect
Military/civilian pay ratio	1.047[a]	0.37[b]
SRB multiplier	0.150[a]	0.033
Unemployment rate	0.012[a]	0.003
AFQT score	-0.010[a]	-0.002
3YOs	-0.153[a]	-0.034
5YOs	0.464[a]	0.103
6YOs	0.443[a]	0.098
Married	0.658[a]	0.146
FY92-95	-0.032[c]	-0.007
Sea duty	0.689[a]	0.153
Constant	-1.624[a]	

a. Zero lies outside the 99-percent confidence interval for this coefficient.
b. Measures the percent change in the reenlistment rate given a 1-percent increase in basic pay.
c. Zero lies outside the 95-percent confidence interval for this coefficient.

Personal characteristics

Consistent with previous research, individuals with higher ability (measured by AFQT scores) are less likely to reenlist. Similarly, married people are significantly more likely to reenlist than their single counterparts. Our results also indicate that personnel currently on sea duty are the most likely to reenlist.

The marginal effects for the set of years-of-obligation dummies suggest that the propensity to reenlist is positively related to the length of the initial enlistment contract. These marginal effects are measured

relative to the reenlistment rate of 4YOs; the pattern of the marginal effects suggests that, in general, the reenlistment rate increases with the length of initial enlistment contract.

Unemployment rates

Consistent with the bulk of previous research, our model indicates a significant, positive relationship between the unemployment rate and the propensity to reenlist. The rationale behind this relationship is that, as the prospects of civilian employment decrease, one is more likely to choose to remain in the Navy.

While this relationship is statistically different from zero, the marginal effect suggests that this relationship is extremely small. We estimate that an increase in the unemployment rate of 5 percentage points (a huge increase relative to today's economic environment) would increase reenlistment by only 1 percentage point. Our conclusion, then, is that reenlistment during the period on which we focus is relatively insensitive to changes in the local economy.

Pay effects

The coefficient on the military/civilian pay ratio is positive and statistically significant, suggesting that increases in basic pay do lead to increases in reenlistment. It is difficult to translate either the coefficient or marginal effect on *relative* military pay into a relationship between changes in the *level* of military pay and the propensity to reenlist. Therefore, table 6 presents the pay elasticity of reenlistment, defined as the percentage increase in reenlistment associated with a 1-percent increase in basic pay. An elasticity of 0.37 implies that reenlistment is relatively insensitive to changes in basic pay. An equally valid interpretation, however, is that reenlistment decisions are relatively insensitive to changes in civilian earnings opportunities.

These pay effects are substantially smaller than those found in the previous literature.[37] Earlier research focused primarily on data from

37. For a recent summary of the retention literature and a range of estimates of the relationship between compensation and retention/reenlistment, see [2].

the 1970s and 80s, whereas the data used in this study are taken from the 1990s. The simplest interpretation of this smaller elasticity is that enlisted personnel are *less* responsive to changes in compensation than they were in the past. In other words, it now takes a larger change in compensation to induce the same change in reenlistment. Even taking the differences in time period and methodology into account, however, the estimated pay elasticity seems low.

On the other hand, our estimates suggest that selective reenlistment bonuses are very effective in encouraging reenlistment. As table 6 shows, a one-level increase in the SRB multiplier is associated with an increase in the reenlistment rate of 3.3 percentage points. While this relationship is fairly large, it is important to note that some of these additional reenlistment decisions are potentially made by individuals who would have signed a long-term extension anyway. If this is the case, the actual increases in retention would be smaller than the estimated increases in reenlistment. We subsequently examine this hypothesis when separately modeling the reenlistment and extension decisions.

Rating-specific pay elasticities

The effect of changes in military compensation on reenlistment presented in table 6 measures the change in the average reenlistment rate. Because both the probability of reenlistment and relative military compensation vary across ratings, however, we can estimate the relationship between compensation and reenlistment separately for each rating.[38]

Table 7 lists, for each rating, the pay elasticity of reenlistment, defined as the percentage increase in reenlistment associated with a 1-percent increase in military compensation. Ratings are sorted in descending order by their pay elasticity of reenlistment.

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38. The elasticity of reenlistment with respect to military compensation is calculated as $\beta*(1\text{-}Pr)*$(military/civilian pay ratio), where β is the estimated coefficient on the military/civilian pay ratio and *Pr* is the probability of reenlistment. Because both the military/civilian pay ratio and the probability of reenlistment differ from one rating to the *next*, the estimated elasticity will also vary across ratings.

Table 7. Relationship between military compensation and reenlistment, by rating

Rating	Pay elasticity of reenlistment[a]
MS	0.53
SH	0.49
AK / SK	0.48
AZ	0.47
YN	0.46
Low-Tech AT	0.36
AD	0.34
CTM	0.34
EM	0.33
Low-Tech ET	0.33
MM	0.33
Low-Tech FC	0.31
GSM	0.29
High-Tech AT	0.28
GSE	0.26
High-Tech ET	0.26
High-Tech FC	0.23

a. Measures the percent change in reenlistment for each rating given a 1-percent increase in basic pay.

A comparison of these pay elasticities and civilian earnings opportunities plotted in figure 5 shows a strong relationship between the level of civilian earnings and the responsiveness of reenlistment to changes in military compensation. For ratings with relatively high civilian earnings (e.g., high-tech AT, ET, and FC), reenlistment behavior is relatively insensitive to changes in compensation. For ratings with relatively poor civilian earnings opportunities (e.g., MS, SH), enlisted personnel are relatively responsive to changes in compensation when making reenlistment decisions.

In addition, there is a substantial amount of variation in these pay elasticities across ratings. The estimates suggest, for example, that mess management specialists (MS) are more than *twice* as responsive to changes in compensation as electronics technicians (ET) in highly technical fields. In general, the ratings on which we focus are fairly

well distributed across a wide range of pay elasticities. This is not surprising, given that differences in our elasticity estimates are driven by differences in civilian earnings opportunities.[39] However, these results do suggest that, if policy-makers are interested in specifically targeting specific skills, it is important to realize that pay elasticities will vary from one rating to the next.

Multinomial logit results

The reenlistment model presented in the previous section examines a dichotomous choice between "reenlisting" and "not reenlisting." The choices actually made by enlisted personnel, however, are more complex. In addition to the reenlistment/separation decision, personnel can choose a middle ground by entering into a long-term extension of their initial contract. While not a formal reenlistment, extensions are a potentially important source of retention for the Navy in a period of manpower shortages.

To examine the effects of changes in compensation on retention, we choose to separately examine these effects for reenlistments and long-term extensions. We continue to hypothesize that increases in military compensation lead to increases in reenlistment. The predicted effect on extensions, however, is more ambiguous. General increases in basic pay should increase the likelihood of signing a long-term extension relative to leaving the Navy. The relationship between the probability of reenlistment and the probability of extending one's contract, however, is less certain. For example, if higher basic pay signals that the Navy is a relatively stable source of employment, people may be willing to forgo extensions for reenlistment.

On the other hand, SRBs are available only to those who actually reenlist, and we expect that an increase in SRBs would lead to an increase in reenlistments and a decrease in extensions (e.g., those who would have extended their initial contract now opt to sign a new contract).[40]

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39. See previous footnote. Ratings with higher civilian earnings opportunities will have lower elasticities, holding all else constant. Similarly, ratings with higher reenlistment rates will also have lower elasticities.

40. If a person is willing to extend for 3 or 4 years, he or she is eligible to receive an SRB (if one is offered). The bulk of those who extend, however, do so for less than 3 years.

To estimate these relationships, we explicitly model the decision of enlisted personnel as consisting of three distinct choices: reenlistment, extension, or separation. We make use of the multinomial logit, which is merely an extension of the better-known, two-choice logit model. In the multinomial logit model, the different choices available to the individual are considered "competing risks" because the acceptance of one choice explicitly precludes one's ability to accept another. In other words, the model recognizes the fact that those who choose to reenlist cannot choose to extend their initial contracts.

Table 8 presents the estimates from our multinomial logit model of retention. The first two columns of data display the coefficients and marginal effects, respectively, for the reenlistment equation; the next two are the comparable estimates for the extension equation. In this case, the marginal effects represent the relationship between the explanatory variables and the probability of each specific choice. As a result, each variable can have, in principle, a different effect on each choice available to the decision-maker.

Table 8. Multinomial logit estimates of retention model

	Reenlistment		Long-term extension	
Variable	Coefficient	Marginal effect	Coefficient	Marginal effect
Military/civilian pay ratio	0.990[a]	0.38[b]	-0.537[a]	-0.53[c]
SRB multiplier	0.131[a]	0.034	-0.222[a]	-0.016
Unemployment rate	0.011[a]	0.003	-0.014[a]	-0.001
AFQT score	-0.008[a]	-0.003	0.013[a]	0.001
3YOs	-0.178[a]	-0.035	-0.188[a]	-0.007
5YOs	0.406[a]	0.101	-0.495[a]	-0.038
6YOs	0.300[a]	0.106	-1.756[a]	-0.107
Married	0.696[a]	0.146	0.371[a]	0.006
FY92-95	-0.053[a]	-0.008	-0.180[a]	-0.009
Sea duty	0.733[a]	0.152	0.473[a]	0.011
Constant	-1.533[a]		-2.422[a]	

a. Zero lies outside the 99-percent confidence interval for this coefficient.
b. Measures the percent change in reenlistment given a 1-percent increase in basic pay.
c. Measures the percent change in extensions given a 1-percent increase in basic pay.

Pay effects

The coefficient on the military/civilian pay ratio in the reenlistment equation is once again positive and statistically significant. Furthermore, the pay elasticity of reenlistment is statistically identical to that from the previous model; we estimate that a 1-percent increase in basic pay leads to a 0.38-percent increase in reenlistment. Similarly, the multinomial logit results suggest that an increase in SRBs by one level will increase reenlistments by 3.4 percentage points.

The relationship between selective reenlistment bonuses and long-term extensions is negative and statistically significant. The interpretation is that an increase in SRBs by one level will decrease extensions by 1.6 percentage points. This makes sense because the overwhelming majority of those who sign long-term extensions do not receive SRBs.

It is reasonable to assume that individuals who forgo a long-term extension because of increases in SRBs do so in order to formally reenlist.[41] The *net* effect of increases in SRBs on retention, then, is 1.8 percentage points for an increase in SRBs by one level (retention effect = reenlistment effect + extension effect, or 1.8 = 3.4 - 1.6). In other words, while a one-level increase in SRBs raises reenlistment by 3.4 percentage points, some of this increase (1.6 percentage points) results from individuals substituting a reenlistment decision for a decision to extend. This estimate is remarkably close to the conclusions of [2], which states that a good "rule-of-thumb" is that a one-level SRB increase raises the reenlistment by about 2 percentage points.

41. While this assumption cannot be tested, it is the most reasonable interpretation of our estimates. Individuals receive SRBs only if they reenlist, and those who forgo an extension because of a higher SRB are likely doing so because they prefer to receive the SRB. Therefore, increases in SRBs induce a substitution of reenlistments for long-term extensions.

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Military compensation and enlisted manning shortfalls—the case for greater flexibility

In principle, one can use our estimates of the relationship between changes in military compensation and changes in reenlistment to estimate the changes in compensation necessary to eliminate manning shortfalls. Given the low estimated pay elasticities, however, we focus on the general implications of our estimation rather than specifically calculate increases in compensation.

Our analysis has demonstrated that, in general, ratings with the most significant manning shortfalls have the largest civilian earnings opportunities. Although this is consistent with many preconceptions, it is less well known that these ratings also have the highest levels of military compensation. The existence of manning difficulties despite high levels of military compensation does *not* imply that military compensation is an ineffective tool to attract and retain personnel. On the contrary, our estimates of the relationship between changes in compensation and reenlistment propensities suggest a direct link between pay and the decision to remain in the Navy. Our analysis suggests that the current levels of compensation are *not sufficient* to address the manning problems faced by these highly technical ratings. In other words, greater flexibility in military compensation would help to alleviate manning shortfalls.

To demonstrate this point, table 9 compares earnings differentials within the military with comparable earnings differentials within the civilian sector. Again, ratings are listed in descending order by their FY98 manning levels.[42] The first data column compares military earnings at 45 months of service of the median individual in each rating with those of the median individual in the MS rating. For each

42. The MS rating is not listed because it is used as a comparison group. The CTM and GSE ratings are not listed because they have too few people at exactly 45 months of service.

rating, the "median individual" is an E-4; differences between ratings at the median, then, occur because of differences in the median SRB from one rating to the next. The median SRB for an MS is zero in FY98, so our measure of military compensation for an MS is just regular military compensation (RMC).[43]

Table 9. Occupational earnings differentials (percentage) in military and civilian sector—FY98

	Military		Civilian
Rating	Median[a]	Maximum[b]	Median[c]
AK/SK	100	153	138
SH	100	135	130
GSM	111	150	207
EM	109	191	197
AD	100	169	204
YN	100	147	156
AT	116	169	267
AZ	100	147	152
MM	114	191	203
FC	139	187	267
ET	122	191	267

a. For each rating, a comparison of median (RMC + SRB) for an individual with 45 months of service to median (RMC + SRB) for an MS with 45 months of service.
b. For each rating, a comparison of maximum (RMC + SRB) for an individual with 45 months of service to minimum (RMC + SRB) for an MS with 45 months of service.
c. For each rating, a comparison of median civilian earnings for an individual with 45 months of service to median civilian earnings for an MS with 45 months of service.

43. We do not have actual data on RMC for each individual. According to military compensation tables provided by ASD (FMP), however, basic pay in FY98 is approximately 65 percent of RMC for E-4s without dependents and 60 percent of RMC for E-4s with dependents. Using this scale factor, we can estimate RMC for each person. SRBs are measured as the average annual amount of the bonus (monthly basic pay times the bonus multiplier). Our estimate of military compensation for each individual, then, is the sum of these two components.

The data in the first column confirm that there is some variation in military compensation from one rating to the next, even holding length of service and paygrade constant. About half of the ratings on which we focus have the same median earnings as an MS, but other ratings have between 9 percent (EM) and 39 percent (FC) higher earnings than an MS.

In contrast, earnings differentials in the civilian sector are significantly larger. The last column of table 9 displays, for each rating, median civilian earnings for an individual with 45 months of service to the median civilian earnings for an MS.[44] In the civilian sector, earnings differentials range from 30 percent (SH) to earnings more than *2.5 times as high* (ET, FC, AT). In no case do median differentials in the military come close to approaching those in the civilian sector.

Furthermore, the *maximum observed* differentials in the military do not even match the *median* differentials in the civilian sector. The middle column displays the largest differentials in the military that we observe for individuals with 45 months of service. For each rating, the highest observed levels of compensation are compared to the lowest observed levels of compensation for an MS. These differentials are, by definition, larger than the median differentials for the military, and range from 35 percent (SH) to 91 percent (EM, ET, MM). Even in the most extreme scenario, then, occupational differentials in the military do not match the variation in earnings found in the civilian sector. In addition, ratings that come the closest to matching differentials observed in the civilian sector generally have the highest manning levels, whereas ratings with the greatest manning shortages are those for which the civilian differentials dwarf those found in the military.

Despite having the largest earnings in the military, our analysis suggests that even *higher* military compensation in these highly technical

44. The MS rating has the lowest civilian earnings of all the ratings on which we focus. Although using another rating as our reference point would lower the civilian differentials, the underlying message would not change: occupational differentials are significantly larger in the civilian sector than in the military.

ratings can help to alleviate manpower shortages. The current level of compensation is not sufficient to meet the Navy's manpower needs. More flexibility is needed in the military compensation system to effectively address manpower shortages if and when they occur.

Conclusion

This paper takes a different approach to the debate over the existence of a civilian-military "pay gap." Rather than examine the pay profiles of representative civilians and enlisted personnel to assess whether military pay lags that of their civilian counterparts, this research memorandum makes two important departures from the traditional analysis.

First, recognizing that different enlisted personnel face very different civilian opportunities, we link Navy enlisted ratings to comparable civilian occupations to obtain reliable estimates of civilian earnings. Second, we do not examine the levels of military and civilian compensation to argue that military pay is "too high" or "too low." Instead, we use manning levels and reenlistment behavior in these ratings to indicate whether military compensation is responsible for the manning difficulties in many enlisted ratings.

An analysis of manning levels indicates that most ratings on which we focus have some sort of manning problem—chronically low sea manning, difficulty filling shore billets, or falling manning levels over time. When we look at the most recent data, however, it is the highly technical ratings that have the most severe manning problems.

Our results suggest that there is significant variation in civilian earnings opportunities across ratings. Furthermore, this variation is consistent with our expectations of the opportunities of enlisted personnel. Those in the Navy with the most technical skills and the most training could earn the highest salaries in the civilian economy. Although people in these ratings command the highest civilian earnings, they also receive the largest military compensation among the ratings on which we focus.

We also find a positive and statistically significant relationship between the level of military compensation and the probability that

an enlisted member chooses to reenlist. Specifically, we estimate that a one-level increase in selective reenlistment bonuses raises reenlistment by about 2 percentage points. These results imply that increases in rating-specific compensation could be used to alleviate manning difficulties in ratings with significant problems.

Finally, our results show that many of the highly technical ratings are having manning difficulties *despite* offering the highest compensation in the Navy. Our interpretation of these results is not that compensation is irrelevant; on the contrary, our estimation indicates that changes in pay do lead to real changes in the behavior of enlisted personnel. We interpret this relationship between compensation in these ratings and continued manning problems as an indication that this compensation, although relatively high, is not high enough. If the Navy hopes to alleviate manning shortages through increased retention in these ratings, it needs both the flexibility and the financial capability to increase compensation in these ratings.

Appendix: Enlisted ratings and comparable civilian occupations

Table 10 lists the matches of ratings and civilian occupations we consider in our analysis. Column 1 shows each rating; where the civilian occupations to which a rating is matched vary by NEC, these NECs are listed in column 2. The third column presents the 3-digit classification used by the CPS, the 1990 Census of Population Occupation Classification. Finally, column 4 describes the civilian occupation used in the CPS.

Table 10. Enlisted ratings and comparable civilian occupations

Rating	NEC	3-digit code	Description
AD		508	Aircraft engine mechanics
AK		359-374	Material recording, scheduling, and distributing clerks
AT	65xx, 66xx, 67xx, 79xx[a]	55	Electrical and electronic engineers
AT	All other NECs[b]	525	Data processing equipment repairers
AZ		325-336	Records processing occupations, except financial
CTM		523-533	Electrical and electronic equipment repairers
EM		523-533	Electrical and electronic equipment repairers
ET	14xx, 15xx[a]	55	Electrical and electronic engineers
ET	All other NECs[b]	525	Data processing equipment repairers
FC	11xx[a]	55	Electrical and electronic engineers
FC	All other NECs[b]	525	Data processing equipment repairers
GSE		55, 694-699	Electrical and electronic engineers; plant and system operators
GSM		518-519, 694-699	Industrial machinery repairers, machinery maintenance occupations; plant and system operators
MM		518-519	Industrial machinery repairers, machinery maintenance occupations
MS		434-444	Food preparation and service occupations
SH		263-278	Sales workers, retain and personal services
SK		359-374	Material recording, scheduling, and distributing clerks
YN		313-315	Secretaries, stenographers, and typists

a. For a 4-digit NEC, the notation "abxx" indicates that NECs beginning with the numbers "ab." For example, 65xx indicates all NECs from 6500 to 6599.

b. Individuals with Nuclear Field NECs are excluded from the analysis.

References

[1] Congressional Budget Office. *What Does the Military "Pay Gap" Mean?* Jun 1999

[2] Matthew S. Goldberg. *A Survey of Military Personnel Retention Models,* forthcoming (CNA Research Memorandum D0002469.A1)

[3] Linda C. Cavalluzzo and Jeremy A. Arkes. *Comparisons of Enlisted and Civilian Pay,* Aug 1998 (CNA Annotated Briefing 98-88)

[4] Michael L. Hansen and Peter Gottschalk. *Is the Proportion of College Workers in "Non-College" Jobs Increasing?* Sep 1999 (Boston College Department of Economics Working Paper 429)

[5] Joyce S. McMahon. *The Military Pay System: How Does It Work?* Mar 1993 (CNA Research Memorandum 92-114)

[6] Federico E. Garcia and Ernest H. Joy, CAPT, USN, with, David L. Reese. *Effectiveness of the Voluntary Education Program,* Apr 1998 (CNA Research Memorandum 98-40)

[7] Curtis L. Gilroy, David K. Horne, and D. Alton Smith (eds.). *Military Compensation and Personnel Retention: Models and Evidence,* Feb 1991 (United States Army Research Institute for the Behavioral and Social Sciences)

[8] Timothy W. Cooke, Alan J. Marcus, and Aline O. Quester. *Personnel Tempo of Operations and Navy Enlisted Retention,* Feb 1992 (CNA Research Memorandum 91-150)

[9] Martha E. Shiells and Joyce S. McMahon. *Effects of Sea Duty and Advancement on First-Term Retention,* Jun 1993 (CNA Research Memorandum 92-205)

[10] Charles Dale and Curtis Gilroy. *The Economic Determinants of Military Enlistment Rates*, Sep 1983 (United States Army Research Institute for the Behavioral and Social Sciences)

[11] Joyce S. McMahon. *A Retention Model for Navy Physicians*, Jun 1989 (CNA Research Memorandum 89-62)

[12] James R. Hosek and Christine E. Peterson. *Reenlistment Bonuses and Retention Behavior*, Mar 1985 (RAND Publication R-3199-MIL)

[13] Department of Defense: Office of the Assistant Secretary of Defense, Personnel and Readiness. *Occupational Conversion Index: Enlisted/Officer/Civilian*, Sep 1993 (DoD 1312.1-I)

[14] Aline O. Quester and James S. Thomason. *Projecting the Retention of Navy Careerists*, Dec 1983 (CNA Research Contribution 511)

[15] United States General Accounting Office. *Perspectives of Surveyed Service Members in Retention Critical Specialities*, Aug 1999 (GAO Briefing Report to Congressional Requesters GAO/NSIAD-99-197BR)

[16] D. Alton Smith, Stephen D. Sylwester and Christine M. Villa. *Army Reenlistment Models*, in *The Economic Determinants of Military Enlistment Rates*, Sep 1983 (United States Army Research Institute for the Behavioral and Social Sciences)

[17] G. S. Maddala. *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge: Cambridge University Press, 1983

[18] Stephen L. Mehay and Paul F. Hogan. "The Effect of Separation Bonuses on Voluntary Quits: Evidence from the Military's Downsizing." *Southern Economic Journal*, 1998: 127-139

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