U.S. Navy Promotion and Retention by Race and Sex

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Abstract

The Navy's promotion-retention process involves two successive decisions: The Navy decides whether an individual is selected for promotion, and then, conditional on the Navy's decision, the sailor decides whether to reenlist or leave the Navy. Rates of promotion and retention depend on individuals' demographic and other characteristics, wars and economic conditions and factors that the Navy policy makers can control. Using estimates of these decision-making processes, we examine two important public policy questions: Do Navy promotion and retention rates differ across race and sex? Can the Navy alter its promotion and other policies to better retain sailors, or do war and civilian labor market conditions determine retention?

Key Words: promotion, retention, labor, sex, race

JEL Classification Codes: J45, J7

U. S. Navy Promotion and Retention by Race and Sex

Today's Navy wants to give all its sailors an equal chance of promotion. However, as individuals make judgments that affect promotion decisions, it is possible that minorities and females are treated unequally. Because the retention of sailors depends on their probability of promotion, unequal treatment may affect which sailors stay in the Navy. Given our nation's military activities in Iraq and Afghanistan, the Navy's leaders are concerned whether its policies will enable it to retain a large proportion of its sailors. We investigate whether there are racial or sex differences in rates of promotion in the career paths of the enlisted individuals and the degree to which Navy policies affect the retention of sailors.

To investigate these issues, we estimate a two-step decision model using a recursive, bivariate probit specification. First, the Navy decides whether to promote sailors based on their current and past performance and the Navy's current needs. Second, sailors decide whether to remain in the Navy or leave, conditional on whether they are offered a promotion and other Navy policies such as whether they are assigned sea duty. Whether individuals are promoted and whether they stay depends on Navy policies, individuals' characteristics, economic conditions in the civilian labor market, and conditions of war or peace. To estimate the model, we use data on virtually all Navy enlisted personnel from January 1997 through May 2008.

Our analysis of promotion and retention differs from previous studies, most of which looked at large corporations. Two of the best-known, early studies on promotions are Wise (1975a, b). Wise investigated the relationship between personal attributes and job performance as measured by the rate of promotion. His basic model is a degenerate (most states are zero) first-order Markov model. The firm decides whether to promote and the individual decides whether to stay or leave, but these decisions are not estimated separately. The transition probability is estimated independent of the grade level using a maximum likelihood method. Other methods that have been used to study promotions include ordered multinomial models (e.g., Jones and Makepeace, 1996), multinomial system of censored equations (e.g., Schmidt and Witte, 1989), and random-effects models (e.g., McDowell, et al., 1999).

Our superior data allow us to use a methodology that differs from previous studies in two critical ways. First, we control for individuals' abilities much more thoroughly than in earlier

studies. We have data on individuals' current and past performance as well as on their aptitude and ability, as measured by the individual's Armed Forces Qualifying Test (AFQT) score. The AFQT is based on the individual's verbal and math scores, including word knowledge, paragraph comprehension, arithmetic reasoning, and mathematics knowledge. Second, we separately estimate equations for the firm's (Navy's) promotion decision and the individual's retention (reenlistment) decision. Many previous studies could only determine whether an individual was both promoted and stayed with the firm.

In the next section, we describe the basic background for the promotion structure and estimation. Then, we describe the relationship between the observed data and the promotion probabilities. The data are discussed in Section 3. In Section 4 we discuss our main empirical results. In Section 5 we use simulations to examine our key policy questions. We draw conclusions in Section 6.

I. Navy Pay Grades and Promotion Rules

The Navy sets many requirements on its workers. We incorporate these rules in our estimation model.

Sailors are assigned to pay grades E1 through E9. With few exceptions, a sailor must spend a minimum time in any given grade before promotion is possible. After a sailor has spent the minimal time period in a grade and demonstrated a minimal level of performance, their probability of promotion is positive until the individual has spent the maximum permitted time in that grade without a promotion and is forced to leave the Navy.

Sailors start in pay grade E1 and are virtually automatically promoted to E2 and then E3. Promotions to higher ranks are not guaranteed. The promotions we examine, from E4 through E6, are based on largely objective performance evaluations.[1] Promotion to E7 also involves a record review by a selection board. (The decision to promote someone to E8 or E9 is made by a selection board based on a number of factors, some of which are highly subjective. We do not examine these cases.) Consequently, we concentrate on promotions to E4 through E7, where fewer factors are subjective.

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[1] Our model can also capture demotions—moving to a lower pay grade. However, we do not discuss demotions here because there are only a handful of such cases.

To try to ensure that all sailors are treated fairly and that only the best are promoted, the Navy uses a formal, systematic policy.[2] Promotions to ranks E4 through E7 are based on an individual's Final Multiple score, which is a pay grade-specific value for each individual in each promotion period. The Navy promotes sailors, within skill groups and specialties, to the next pay grade starting with highest individual Final Multiple score until all its vacancies in that pay grade are filled. The Final Multiple score for promotions to Grades E4 through E6 is a weighted average of five components: time in grade, the Performance Mark Average (PMA), an examination score, the Pass not Advance (PNA) measure, and awards. Most of the aspects of this process are objective and leave no room for discrimination.

The first component of the Final Multiple score for ranks E4 through E6 is time in service in a pay grade. Individuals cannot take the required pre-promotion exam until they meet minimum time in grade (TIR), which varies by pay grade.[3]

The second component is the Performance Mark Average (PMA). The PMA is based on the individual's fitness report, FITREP. A supervisor evaluates an individual on team work, leadership, and other factors. Each sailor is assigned a PMA (four-point scale) score. An individual must receive a PMA greater than or equal to 3.6 to be eligible to take the pre-promotion exam: Early Promote (4.0 points), Must Promote (3.8), Promotable (3.6), Progressing (3.4), and Significant Problems (2.0 points). The navy has tried to force performance mark averages into a bell curve across all individuals, but that has seen limited success. If discrimination or other non-objective criteria enter into the Final Multiple score, they enter through the PMA.

The third component is the pre-promotion examination score. All eligible individuals must take the exam. In each promotion cycle (approximately every six months depending on the pay

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[2] The Navy is very sensitive about possible discrimination. Navy studies of potential discrimination go back decades. For example, Golfin and MacIlvaine (1995) studied the promotion opportunities of enlisted personnel with an emphasis on race and found that Whites were promoted at a higher rate than nonwhites. In response to these studies, the Navy has tried to prevent discrimination by using formal evaluations that leave relatively little room for subjective decisions.

[3] The Minimal time for promotion is based on two components: Total active federal service and minimal time in pay grade. Minimum required time in pay grade is 9 months for E1 to E2 and E2 to E3, 6 months for E3 to E4, 12 months for E4 to E5, 36 months for E5 to E6 and E6 to E7.

grade), the Navy sets a cut score, which is the minimum exam score that an individual must obtain to be considered for promotion. An individual who fails to pass must take another exam in the next promotion cycle. In our empirical work, we use a variable called Pass, which is one if the sailor takes and passes this test and the Final Multiple exceeds the cut score.

The fourth factor is the Pass Not Advance (PNA) measure. Individuals who were not promoted the first time they were eligible because of a lack of vacant positions are awarded PNA points that are added to the individuals' final multiple value in the next evaluation period. Thus, PNA points give such individuals a slight advantage over first-time test takers.

The fifth component is Awards. There are 28 different awards listed for which points can be earned, with points varying across these awards. For example, 10 points for the Medal of Honor, 5 points for the Navy Cross, and 2 points for an Executive Letter of Commendation. Such major awards are extremely uncommon.

Thus, the Final Multiple is a function of four objective measures and one subjective measure, the PMA.[4] Some subjectivity may also enter into decision to promote a few people outside of this system—early promotion—or to decide which sailor among several with the same Final Multiple score is promoted. Finally, promotion from E6 to E7 involves one more stage that introduces subjectivity. All candidates with adequate final multiples are evaluated by an advancement board similar to the promotion boards for officers. Candidates are compared against each other in front of a panel of raters and an iterative process is used to reach some pre-established number of advancements.

Regardless of whether or not they are promoted, toward the end of a sailors' current contract, they must decide whether to reenlist for an additional period of service. Most sailors reenlist for a period of four years at a time, though they may also be able to reenlist for five or six years. Under certain circumstances, sailors can extend their service up to two years.[5]

All sailors are subject to the High Tenure Policy, which sets a maximum time that an individual has in which to be promoted to the next pay grade from the current one: 10 years for

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[4] For promotions to Grades E4 and E5, Multiple = $0.34 \times$ Score $+ 0.36[(PMA \times 60) - 156] + 0.13[(TIR \times 2) + 15] + 0.13(PNA \times 2)$, where Score is the promotion test score. For Grade E6, Multiple = $0.30 \times$ Score $+ 0.415[(PMA \times 60) - 130] + 0.13[(TIR \times 2) + 19] + 0.11(PNA \times 2)$. For Grade E7, Multiple = $0.60 \times$ Score $+ 0.40(PMA \times 13)$.

[5] See Golan and Blackstone (2008) for a detailed study of Navy compensation, bonuses, and retention.

E4, 20 years for E5 and E6, and 24 years for E7.[6] However, we did not observe any cases in which the High Tenure Policy was imposed. Apparently individuals who are not promoted receive the signal and leave well before they hit their maximum time limit. Consistent with this observation, we did not observe changes in average tenures when the rules on High Tenure changed.

II. Model

To examine the Navy's promotion decision and an individual's reenlistment decision, we estimate a bivariate probit model. The first equation reflects the Navy's decision whether to promote based on the individual's performance and ability as well as Navy need for sailors. The second equation represents the individual's decision whether to reenlist or leave the Navy conditional on whether the individual is offered a promotion, the individual's preferences as capture by demographic variables, and civilian economic conditions.

Let y_{i1} be a binary variable that equals one if the individual is promoted and y_{i2} is a binary variable that equals 1 if the sailor remains in the Navy. We estimate a probit system that reflects a form of sample selection (Greene, 2008) where sailor i's decision, y_{i2}, is conditional on the Navy's decision, y_{i1}, about sailor i:

$$z_{i1} = \beta_1' x_{i1} + \varepsilon_1, \qquad y_{i1} = \text{sign}(z_{i1}), \tag{1}$$

$$z_{i2} = \beta_2' x_{i2} + \gamma y_{i1} + \varepsilon_2, \quad y_{i2} = \text{sign}(z_{i2}), \tag{2}$$

where z_{i1} is the latent variable related to whether the individual is promoted by the Navy, z_{i2}, is the latent variable for re-enlistment, and the errors are assumed to be distributed $[\varepsilon_1, \varepsilon_2] \sim$ BVN(0,0,1,1,ρ), where BVN is the bivariate normal distribution and ρ is the correlation coefficient between the two equations. This model is based on the model employed by Burnett (1997) and developed further by Greene (1998, 2008). We estimate these probabilities and ρ using a maximum-likelihood, bivariate probit method in the software package NLOGIT.

III. Data

Our Navy data set covers virtually all enlisted sailors in all skill groups (occupations) and pay grades (E3 through E7) from January 1997 through May 2008. We had to drop about one-seventh of the observations due to missing data for some variables (these observations do not change the basic moments).

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[6] The navy changed the High Year Tenure for E5 from 20 to 14 years in 2005.

A. Truncation

We start following an individual in the month in which they first receive a promotion from January 1997 through May 2008. We then record information about that individual for each successive 12 month period. (We experimented with shorter and longer time periods and found that our results are not very sensitive to the choice of this interval.) Individuals are observed until they exit or until the last period in the data set. There is no natural birth cohort, nor a period cohort, though there is a promotion cohort: people eligible for promotion at each promotion cycle and for each pay grade.

We consider all completed promotion decisions within our time frame, dropping data on times to promotion that are not completed within our time frame. Consequently, the data set may be truncated from the left—if the first promotion occurred in a year prior to the first time an individual is observed in the data—or from the right—if the last observed promotion occurred prior to the last period, May 2008. Because an individual's first observation in our data set is associated with a promotion decision, we do not use information about prior promotion decisions in our estimation. By using this approach, we are able to measure how long it has been since the previous promotion to a given promotion decision. Because we observe all of the enlisted personnel at all pay grades of each skill group during the sample period and because the original data are observed monthly, we find that dropping incomplete promotion period data does not change the properties of our sample. Similarly, right truncation does not create a problem for us for the same reason: We have all the completed promotion/stay decisions during the relevant period.

B. Variables

Our dependent variables are promotion, Equation 1, and retention, Equation 2, which are binary variables. The promotion variable indicates whether an individual is offered a promotion by the Navy and includes those individuals who decide to leave the Navy before their promotion materialized. The retention variable shows whether the sailor remains in the Navy, re-enlisting if necessary.

We first discuss the demographic characteristics, Navy policies, and other explanatory variables that are used in both the promotion and retention equations. Then we discuss those variables that appear in only the promotion or in only the retention equation.

Both equations contain a sailor's Armed Forces Qualifications Test (AFQT) percentile score. The AFQT is given to all new recruits in the U.S. armed forces and measures their arithmetic reasoning, mathematics knowledge, paragraph comprehension, and word knowledge (**official-asvab.com/understand_coun.htm**). Because the Navy accepts only individuals with percentile scores above 30, we observe scores from 30 to 99. Presumably the higher sailors' AFQT value, the more likely they are to be promoted, but the more likely they are to leave the Navy due to greater opportunities in the civilian labor market.

Because very few sailors have completed college, we use two dummy variables to capture education: a high-school-diploma dummy and a post-high-school-education dummy (where the base group is sailors who did not complete high school). As extra education may indicate both capability and self-discipline, we expect more education to increase one's chance for promotion, but to have an ambiguous effect on staying in the Navy.

Whether a sailor is currently on sea duty, which is sometimes voluntary, may affect promotion positively if a supervisor believes that they gain valuable skills. If most sailors enjoy sea duty, being assigned to sea duty may increase the probability of remaining in the Navy.

We have a separate dummy variable for each current pay grade, E4, E5, and E6. As promotion from E3 (the base group) to E4 is relatively easy, we expect the coefficients on higher grade dummy variables to have negative signs in the promotion equation. We expect that sailors at higher pay grades are less likely to leave the Navy for a variety of reasons including higher pay or a decision to make a career in the Navy or a decision to complete the twenty years of service required for receiving Navy's pension for life.

We use three race dummy variables: Black, Hispanic, and other, where White is the base group.[7] The equations also include a female dummy. We interact the race and female dummies with the pay grade dummies to test for racial and sex differences in promotion and retention across the pay grades.

As our sample includes periods of peace and war, we expect rates of promotions and retention to vary over time. We have five time variables. A September 11, 2001 dummy demarks

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[7] For most of the period analyzed, the Navy's classification scheme does not treat Hispanic as an ethnicity but as a race, where the races are mutually exclusive and exhaustive. That is, one cannot be both White and Hispanic or Black and Hispanic.

the shift from the "peace" period to the "war" period. A time trend, Peace Time, increases by one each year through September, 2001, and is thereafter zero. A second time trend, War Time, is zero before September, 2001, and zero thereafter. We also include squared terms for both the time trends. These trends may capture various unobserved effects over time such as changes in patriotism among the sailors and in Navy policies that are not included among the explanatory variables such as retention bonuses and promotion and retention targets. The Navy regularly changes the number of sailors it wants to promote and retain and its policies towards encouraging retention. (Unlike some other branches of the armed forces, the Navy did not have an explicit "stop-loss" policy that prevented sailors from leaving during the post-9/11 period.) In addition, the trend variable captures the change in the ratio of the civilian wage to the Navy wage. The relative pay of enlisted personal has increased over the last two decades. Currently, average military pay is at about 70th percentile of the comparable civilian wage distribution controlling for individuals' experience and other characteristics (Congressional Budget Office, 2004, 2007; Department of Defense, 2005; Grefer 2008).

The remaining variables appear in only one of the equations. The variables in the promotion equation that do not appear in the retention equations are related to Navy policies. To capture possible Navy policy changes not otherwise captured by explicit variables or changes in the attitudes of supervisors over time that might affect the probability of promotion, we interact the race and sex dummies with the time trends.[8]

The AFQT was designed to be an unbiased test across race and sex (see **official-asvab.com/fairness_coun.htm**). However because it tests mathematical and verbal skills that are taught in schools, if the education of some demographic groups is inferior to that of others, that group's AFQT scores could be systematically lower than those of other groups. To capture any such effect, we interact the race and sex variables with AFQT.

In addition to the dummy for current assignment to sea duty, the promotion equation includes two measures of sea duty over a sailor's career to date: the share of time in the Navy spent on sea duty, and that share squared, which captures nonlinearities. Some Navy experts told us that they expected sailors who spend a substantial portion of their career at sea would be more likely to be

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[8] Although we know of no reason why these interaction variables should appear in the retention equation, we experimented with including them. When we did so, all of their t-statistics were very close to zero.

promoted. These variables are not included in the retention equation on the grounds that the share of one's career already spent at sea can be viewed as "sunk costs."

The Pass dummy captures whether an individual was eligible to take the exam and passed it. The Pass dummy is not a perfect indicator because the Navy occasionally promotes people who have not taken or passed the exam if they have an extraordinary need for personnel in certain positions.[9]

The Navy may choose not to promote all eligible sailors depending on "demand" and "supply" conditions. The Navy's promotion demand variable is Vacancies, the number of open positions to be filled by promotions at a given exam cycle for a given pay grade and a specific occupation. The supply of sailors for promotion is the variable Takers, which is the number of individuals, who are potentially eligible for promotion, for a period, pay grade, skill and specialty and have taken and passed the exam. The promotion equation includes the ratio of demand to supply, Vacancies/Takers, and that ratio squared to capture nonlinearities.

The variables in the retention equation that do not appear in the promotion equation mostly concern family considerations and economic conditions that affect the civilian labor and housing markets. We expect married sailors to be more likely to remain in the Navy than those who are single. We also include the interaction of married and current sea duty. As a sailor on sea duty receives bonus pay and may prefer (or not prefer) being at sea, the sign of this interaction is ambiguous.

How long a sailor has been in the Navy is important because a sailor gets a full pension after 20 years of service. A sailor's length of service is 0 to 6 years and 1 month of service in Zone A; 6 year, 2 months to 10 years, 1 month of service in Zone B; 10 years, 2 months to 15 years in Zone C; 16 to 20 years in Zone D; and more than 20 years in Zone E (less than 1% of sailors). We interact the zone dummies with a sailor's length of service (months in the military). Thus, these dummies and the interactions allow the effect of length of service to vary in the different

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[9] We do not include the Performance Mark Average (PMA), Pass not Advance (PNA), and the Final Multiple score because they may be a function of the race and sex dummies, which are included in the equations. In particular, the PMA (and hence the Final Multiple) is a subjective evaluation of an individual by the sailor's supervisor, who might be partially influenced by the sailor's race or sex. To test for possible subjectivity, we regressed PMA and the Final Multiple Score on demographic variables. Many of the coefficients on race and gender were statistically significantly different from zero.

zones. The closer one is to having served 20 years, Zone D, the less likely one is to leave. To prevent sailors with relatively little time in the Navy from leaving, the Navy sometimes provides a retention bonus to sailors in Zone A if they are performing a job that the Navy has difficulty filling. The Navy may provide a smaller bonus for someone in Zone B, but it rarely provides a bonus for a sailor in Zone C, and does not provide a bonus for more senior sailors.

Time in rank affects whether a sailor stays in the Navy because someone who is not promoted quickly may choose to leave before hitting the maximum time when the sailor must leave if not promoted. It is also important in determining whether a sailor is promoted; however, the Pass dummy already captures this eligibility, so time in rank is not separately included in the promotion equation.

Base pay is a sailor's earning other than from bonuses, such as one receives while on sea duty or to induce one to reenlist. Base pay is determined by pay grade and seniority. The only way a sailor can receive a higher wage is by being promoted. Presumably a sailor compares this base pay to what they could earn in the civilian market. However, this variable is highly collinear with one's pay grade and other factors that are already included in the equation.

To capture conditions in the civilian labor and housing markets, we supplement our Navy data base with two macro variables that are lagged one period prior to the observation: the Gross Domestic Product (Bureau of Economic Analyses) and the unemployment rate (Bureau of Labor Statistics).[10]

We also include an estimate of each sailor's probability of being employed in the civilian labor market. Using data from the Bureau of Labor Statistics' Current Population Survey (CPS) , the American Community Survey (ACS), and the National Longitudinal Survey (NLS) of Youth (1979 and 1997 cohorts), we estimated an employment-unemployment probit equation for the civilian labor market that includes individual characteristics that correspond to those in the Navy data. In the probit, the data are weighted to reflect the over-sampling of veterans in the CPS data.[11]

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[10] Initially, we included many more macroeconomic variables, such as the NASDAQ closing index (Commodity Research Bureau) and the mortgage rate (Federal Reserve Bank of St. Louis), but we found that they had virtually no additional explanatory power.

[11] An appendix providing a detailed definition and explanation of all the variables used in the estimation is available upon request. We considered estimating a Heckman-type model where the first equation is the employment probit, from which one obtains a Mills ratio that is used in a

The final variable in the retention equation is the (endogenous) promotion dummy. Sailors decide whether to remain in the Navy after learning whether they are promoted.

IV. Empirical Results

We estimated our model separately for each of the 21 skill groups: Administration, Aviation Air Crew, Aviation ATC, Aviation Boatswain, Aviation Mechanical, Aviation Meteorologist, Crypto Intelligence, Diver Special Warfare, Medical, Nuclear, Seabee, Submariner Electronics, Submariner Other, Supply, Surface Combat Electronics, Surface Combat Weapons, Surface Deck, Surface Electrical, Surface Engineering, Surface Operations, and Surface Repair.

The results are qualitatively similar across most of these skill groups. Consequently, due to space constraints, we discuss results for only the Administration group, which is a very large skill group with a wide range of backgrounds and abilities. Their job descriptions include yeoman (administrative and clerical work), personnel specialist, Navy counselor (career and recruiting), musician, mass communication specialist, and legalman (similar to a paralegal). One motivation for choosing this specific group is that it contains a large share of minority groups (larger than their share in the population) and that this group contains sailors with a large range of AFQTs scores.

We start by presenting summary statistics. Then, we discuss the estimates of the recursive, bivariate model, emphasizing race and sex issues. Next, we compare this bivariate model to a simple probit.

A. Summary Statistics

The mean values of the relevant variables for the Administration group from 1997 to 2008 are presented in Table 1. The first column is for all sailors, the next four show the comparable means for the four racial groups, and the last two are for males and females.

Averaged over the entire sample period, the Navy annually promotes 31% of all sailors and of male and female sailors in any given year; 34% of Whites; and 29% of other racial groups. Nearly all, 93%, of sailors remain in the Navy, with little variation across demographic groups.

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second, wage equation. However, the resulting estimated wage for a sailor would be a linear function of the sailor's personal characteristics, which are already included in the retention equation, and hence nearly perfectly collinear. The unemployment estimate is a highly nonlinear function of these characteristics; hence it does not pose the same collinearity problem.

The shares of sailors that are promoted and stay, promoted and leave, not promoted and stay, and not promoted and leave, vary little across demographic groups.

There is relatively little variation across pay grades or zones of service among racial groups. The fraction of sailors in Zone A (0 to 6 years and 1 month of service) ranges from 34% for Black sailors to 37% of White, Hispanic, and other races. However, females have substantially less experience than males, so that 45% of females are in Zone A but only 33% of males. Females are much more likely to be in E4, 32%, than are males, 23%.

Minorities and males constitute a larger share of the Navy than of the civilian population. The share of female sailors who are minorities—particularly Blacks—is larger than for males.

The mean AFQT intelligence or ability score is in the 55th percentile for Administration. (In contrast, the average score is in the 89th percentile for sailors in Nuclear, which is a more selective skill group.) Whites have a higher mean score and Blacks have a lower mean score than do the other demographic groups.

Blacks and females are more likely to have a high school diploma than other sailors. In Administration, 14% of those in the other races group have some post-high school education, which is at least double the average for the other demographic groups.

Substantially more male sailors, 64%, are married than females, 47%. The share of Blacks who are married, 56%, is 4 to 5 percentage points less than for the other racial groups.

More importantly, 39% of sailors have a Pass variable equal to one (not only did they pass the exam but their Final Multiple exceeds the cut score so that they are eligible for promotion). The share that Pass, ranges from 36% for Blacks, 38% for Hispanics, 41% for Whites, and 43% for other races. Both males and females average 39%.[12]

The fraction of sailors on current sea duty varies relatively little across these groups, with females being 5% more likely to be on sea duty than males. This difference is due to females being more likely to be starting their Navy careers. Over their entire careers, males have spent 47% of their time at sea compared to 40% for females.

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[12] The share of sailors who take and pass the promotion exam the first time (not shown in Table 1) is 58% for males and 56% for females. This share varies slightly across races, from 60% for Whites to 55% or 56% for Blacks, Hispanics, and other races.

Our estimates of the probability of a sailor finding a civilian job range from 92% to 96% for these demographic groups, with Blacks, 92%, and females, 93%, having lower probabilities than other groups.

The means for most variables differ little between those for all sailors within a demographic group and for just those who were promoted (not shown separately in Table 1). One exception is that time in rank is higher for those who were promoted. The other exception is the time at sea where those promoted have on average, four or five fewer months at sea than the overall average for any given group.

Sailors may take into account recent promotions and whether they are on the fast track as measured by time in rank when deciding whether to stay in the Navy. The first column of Table 2 shows that the frequency promoted falls from 79% at E3 and 38% at E4 to 23% at E5 and E6. The fraction of sailors who remain in the Navy even though they were not recently promoted rises with the pay grade—20% at E3, 59% at E4, 72% at E5, and 76% at E6—because promotions are known to be less frequent at higher ranks and the pay is higher. Relatively few sailors who are promoted leave: essentially none at E3 and only 5% at E6.

B. Bivariate Probit

The recursive, bivariate model, Equations 1 and 2, for the Administration group fits the data reasonably well, as the prediction table at the bottom of Table 3 shows. Most of the coefficients have the expected signs. We concentrate on discussing those coefficients for which we can reject the hypothesis that the coefficient is zero at the 0.05 level.

We first discuss those variables that appear in both equations. The higher a sailor's AFQT, the more likely the sailor is to be promoted, but the less likely to stay in the Navy. A sailor with some post-high school education is more likely to be promoted. One with a high school diploma is more likely to stay in the Navy. Being on current sea duty raises the likelihood of staying in the Navy, but does not statistically significantly affect the probability of promotion. The probability of promotion is lower in the higher pay grades, E4, E5, and E6 than in E3. Sailors in E5 and E6 are more likely than those in E3 or E4 to remain in the Navy.

The rest of the variables that appear in both equations involve race, sex, and time trends, as well as their interactions. Given the interactions, apart from one exception, we cannot easily interpret their effects from the coefficients alone, so we postpone a discussion until the next

13

section, where we use simulations (and decompositions) to interpret the results. The one exception is the stronger impact of AFQT on females.

We now turn to those variables that affect promotion but not retention. Not surprisingly, the probability is higher if one passes the promotion exam (Pass = 1). There are two reasons why this variable is not a perfect indicator. First, the Navy occasionally promotes individuals who do not have sufficient time in rank or who failed the exam if the Navy's need for sailors at higher levels is sufficiently great. Second, promotion is also dependent on the Navy's demand and the number of candidates eligible for promotion. As the ratio of the number of vacancies at higher levels to the number of sailors taking promotion exams increases, the probability of passing increases (though at a declining rate).

Promotion depends statistically significantly on the share of a sailor's career spent at sea (although, as we already noted, not on whether the sailor is currently on sea duty). Initially the effect on promotion is positive as the share increases up to 22%, but thereafter the effect is increasingly negative as the share grows larger (and sailors have spent 45% of their careers at sea on average).

We test whether the effect of a higher AFQT score on the probability of promotion differs across demographic groups. The interactions are not statistically significantly different from zero for the racial group interactions, but the coefficient on the female interaction is statistically significantly greater than zero. Again, we postpone a discussion of the interaction effects involving race and sex with time to the simulation section that follows.

The remaining variables affect retention but not promotion. Married sailors are more likely to remain in the Navy. While sailors on sea duty are more likely to stay in the Navy, this positive effect is smaller for married sailor than for others. That the effect remains positive for married sailors may be due to the sea duty bonus pay or because the next assignment is more likely to be shore duty.

A sailor's history plays an important role in the decision to stay in the Navy. The longer that a sailor has been in a given rank (that is, not promoted), the more likely that individual will leave. The likelihood of staying in the Navy is higher for sailors with 16 to 20 years of service, Zone D, than others, because sailors are eligible to receive a Navy pension after 20 years.

The lagged GDP has a positive effect while the Navy base pay surprisingly has a negative one. We believe that the base pay result is due to collinearity as the base pay is largely

determined by one's pay grade. As expected, the higher the overall civilian unemployment rate or the lower a sailor's predicted civilian employment probability, the more likely a sailor remains in the Navy. As one would expect, a recent promotion makes it more likely that a sailor remains in the Navy. The estimated correlation between the two equations is -0.375.

We can divide the variables into four main groups: individual attributes (AFQT, education, race, sex and marital status), Navy-related individual attributes (pay grade, pass, base pay, zone, length of service and related interaction variables), Navy policies (vacancies, sea duty status, time at sea, time in rank), and the civilian labor market variables (GDP, unemployment, individual's employment probabilities). The interaction variables involving variables within a group are included with that group. Because some variables appear in both equations and because we are interested in the overall impact of each group of variables, we tested the contribution of each of these groups on the system of promotion and retention equations. For each one of these groups, we can reject the hypothesis that all the coefficients are simultaneously zero at the 0.01 level. Using χ^2 and other information criteria, we examined the relative explanatory power and reduction in uncertainty of four basic groups of variables. The Navy individual attributes contribute the most, followed in order by the individuals' attributes, the Navy policy variables, and the civilian labor market variables.

C. Bivariate Probit vs. Probit

Unlike in our bivariate probit model where we separately examine the decisions of the employer (the Navy) and of the employees (sailors), most previous studies were forced to look at the combined outcome that one was promoted and stayed with the firm. To show how estimating this more restrictive model affects results, we estimate a probit where the dependent variable is one when the individual is promoted and retained and zero otherwise. This probit is reported in the last column of Table 3.

Combining the promotion and retention effects in the probit model masks offsetting effects in the bivariate model. That is, any variable with opposite signs in the promotion and retention equations may appear to have little or no net effect in the probit model. For example in the bivariate probit model, having a higher AFQT score raises the probability of being promoted (first column) and lowers the probability of staying (second column). Here, the net effect in the probit model is positive. A sailor in pay grade E6 is less likely to be promoted than someone in E3 and more likely to remain according to the bivariate model, but less likely to be promoted and

15

stay according to the probit model. Current sea duty does not have a statistically significant effect on promotion, but does have a statistically significant positive effect on staying in the bivariate model. Sea duty reduces the probability of being promoted and staying in the probit model.

A Hispanic in E6 is less likely to be promoted but more likely to stay than a White according to the bivariate model, whereas the Hispanic does not have a statistically significant difference to a White in being promoted and staying according to the probit model. Similar patterns are observed for other racial variables. Thus, the probit model does not capture patterns—particularly those involving race—in the same way as does the bivariate model.

V. Simulations

Because our bivariate probit is highly nonlinear and has many interaction variables, we cannot infer the role of specific variables on the probabilities of promotion and retention from the coefficients alone. To show the effects of specific variables—particularly race and sex variables—we use two methods of simulation. In the next two subsections, we calculate the expected probabilities over the relevant samples, such as a particular racial group, and then average these probabilities. In the last two subsections, we simulate the effect of changing variables on a representative sailor, where we either change a single variable at a time or a group of related variables such as Navy policies or civilian labor market conditions.

A. Promotion and Retention by Race, Pre- and Post-9/11

Given the large number of race interactions with other variables, race can have complex effects on the promotion and retention probabilities. Because the probability of promotion—and to a lesser degree retention—differs substantially before and after 9/11, we report separate simulated probabilities for the two periods. September 11, 2001 occurred roughly in the middle of our period, dividing the peace period before 9/11 from the following war period when our military fought in Afghanistan and Iraq.

We use our estimated model to calculate the expected probabilities for each sailor in the relevant subsample and then average these probabilities. Our estimates reflect the substantial change in the Navy's promotion policies over time. For the overall sample, the probability of promotion fell by about a fourth, going from 44.1% in the peace period to 33.8% during the war period. Table 4 shows the changes in promotion probabilities by race and pay grade during peace and war. The clear patterns that emerge are that promotion probabilities fall over pay grade for

each racial group, Whites are more likely to be promoted than are the other racial groups, and the probabilities of promotion within any pay grade or racial group fell substantially after 9/11.

This drop in the probability of promotion is not mainly due to the war time conditions. Rather it is the result of a long-term draw-down of the Navy starting in the 1990s together with a sudden activation of reserves. As a consequence, there were fewer open slots available for promotions. The end-strength (number of sailors) fell by 35% in the 1990's and another 11% from 2000 through 2008. The end-strength rose from 527 thousand in 1981 to a peak of 593 in 1988 and 1989. From that point, the numbers dropped: 580 in 1990, 435 in 1995, and 373 in 2000. In 2001-2002, the numbers rose slightly, hitting 385 in 2002, but then they fell again, hitting 332 in 2008.

This reduction was achieved by reducing the number of new sailors, so the average experience of sailors rose. As sailors with many years of service tend to remain in the Navy because of the retirement system, the probability of retention did not change as dramatically— from 93.3% to 92.7%—as the probability of promotion fell from peace to war time. This change reflects the effect from a lower probability of promotion, which was partially offset by increased average years of service, increased patriotism, and worsening civilian market conditions.

In the following, we concentrate on the probabilities of promotion and retention. However, the retention probabilities reflect the averaging of different retention rates for sailors who were promoted and those who were not. In Figure 1, panel a shows the probability of retention for various pay grades by year for those sailors who were promoted. Panel b shows the retention probability for sailors who were not promoted. From the beginning of the sample to 2001, the retention probabilities were relatively constant for both groups of sailors. Thereafter, the probability of retention of those sailors who were promoted fell substantially, while the probability of those who were not promoted rose substantially. The net effect is that the share of sailors who remained in the Navy declined only slightly during the war period.

We use simulations and decompositions to show how coefficients and characteristics affect the promotion and retention probabilities vary across races in Table 5. We simulate average probabilities in two ways. First, we simulate the "actual" probabilities (bold type in the table) where we use the coefficients for a given group to calculate the probabilities for each member of that group and average across all the member of the group. Second, we mix and match the coefficients and characteristics other than race so that we can distinguish between the

17

contribution of coefficients, which may capture unequal evaluations for promotion by superiors, and characteristics to the actual differences in probabilities across demographic groups. For example, we ask how Blacks would do if they had the same coefficients as Whites (White coefficients, Black characteristics) or if they had the same characteristics as Whites but their own coefficients (Black coefficients, White characteristics). This type of analysis is similar to "Oaxaca decomposition" (Oaxaca 1973), but we do it for a nonlinear model.

To save space, Table 5 presents detailed results for only the E5 pay grade. We start by examining the pre-9/11 period (the first two columns of numbers in the table). Using each group's own coefficients and characteristics, we estimate that the probability of promotion for Whites, 37.6%, was 3.9 percentage points higher than for Blacks, 33.7%. However, the probability that a sailor stayed in the Navy is 2.7 percentage points higher for Blacks, 95.0%, than for Whites, 92.7%. That is, Black sailors were less likely to be promoted and more likely to stay in the Navy than White sailors. Similarly, Hispanics and other races were less likely to be promoted and more likely to stay in the Navy than Whites (though sailors in the "other" racial group had promotion rate similar to Whites in the pre-9/11 period).

These probability gaps reflect both differences in the coefficients between the races and differences in each group's non-racial characteristics. If we calculate the probabilities using the White coefficients but the characteristics of each race, the promotion probabilities are 37.6% for Whites, 36.5% for Blacks, 43.0% for Hispanics, and 38.2% for others. In other words, if the Navy treated everyone equally in the sense that they had the same coefficients, then the differences in average characteristics would make Blacks less likely to be promoted on average than Whites, while Hispanics and other races would be more likely to be promoted than Whites. Using the White coefficients, the average probability of retention would be lower for Whites than for the three other racial groups given their different demographic characteristics.

If we now do the same type of analysis where we assume everyone has the average characteristics of the White group but the coefficients for their own racial group, then we find that the probability of promotion is 37.6% for Whites, 35.0% for Blacks, 26.6% for Hispanics, and 36.6% for others. Thus, the difference in coefficients is most pronounced for Hispanics.

We can use these two types of analysis to loosely decompose the differences in probabilities between groups into those due to unequal treatment as captured by the coefficients and those due to differing characteristics. For example, the actual difference in promotion probabilities between

18

Whites and Blacks (for E5, pre – 9/11) is 3.9 percentage points (= 37.6% – 33.7%), the difference using White coefficients and varying characteristics is only 1.1 percentage points (= 37.5% – 36.5%), while the difference using White characteristics and varying coefficients is 2.5 percentage points (= 37.5% – 35.0%). Thus, differences in the coefficients—which may capture unequal evaluations by superiors—plays roughly twice as large a role as the difference in characteristics in explaining the overall difference in promotion probabilities between Whites and Blacks.

The comparable percentage point differentials between Whites and Hispanics are 5.7 percentage points (overall), –5.4 percentage points (varying characteristics), and 11.1 percentage points (varying coefficients). One possible interpretation of these results is that Hispanics' superior average characteristics cut half the difference in promotion probabilities due to unequal treatment by superiors.

Has the situation changed as the Navy has shifted from peace to war? The actual gap in promotion probabilities between Whites and Blacks went from 3.9 percentage points before 9/11 to 6.2 percentage points after 9/11, from 5.7 percentage points to 8.7 percentage points for Hispanics, and from 4.3 percentage points to 4.5 percentage points for others. These increased promotion gaps are even more striking given that the probability of promotion fell for all groups.

If we hold characteristics fixed using the average for the White group and vary coefficients, the difference in promotion probabilities were 2.6 percentage points for Blacks, 11.0 percentage points for Hispanics, and 1.0 for others before 9/11. The corresponding differentials during the war years are 2.3, 5.3, and 0.6. Thus, these differentials that may be attributed to Navy actions have shrunk over time.

It follows that the increase in the actual differential must be due to changes in the relative characteristics of the various groups. If we use the White coefficients and vary characteristics across racial groups, the difference in promotion probabilities were 1.2 percentage points for Blacks, –5.4 percentage points for Hispanics, and –0.6 for others during peace time. The corresponding differentials during war are 4.3, 4.7, and 4.1. The major reason why the actual differentials between Whites and other groups have increased over time is due to relative changes in the characteristics of nonwhite groups. These changes in characteristics are so large that they swamp the coefficient effects that go in the other direction.

The changes in retention probabilities over time are much smaller than for promotion probabilities. The probability of staying in the Navy fell by 0.9 percentage points for Whites, 0.7 for Blacks, and 1.0 for Hispanics and others.

Gaps in the promotion probabilities between the races are qualitatively similar between pay grades, but the size of the gaps vary. During the war period, Whites are 8.5 percentage points more likely to be promoted than Blacks in E4, 6.2 percentage points more likely at E5, and 8.2 percentage points more likely at E6.

B. Promotion and Retention by Sex, Pre- and Post-9/11

Males are substantially more likely to be promoted than females in the lower pay grades (up to E5). Females are more likely than males to stay in the Navy at E4, but are less likely at E5 and E6. The overall probabilities of promotion and retention fell for both sexes from the peace to the war periods.

Again, we decompose the differences in the actual probabilities into those based on differences in coefficients and those based on differences in characteristics other than sex in Table 6. For E5, the actual differential between men and women was 2.0 (= 36.0% − 34.0%) percentage points during the peace period. Using coefficients for males and varying characteristics, the differential was 2.5 percentage points. Using characteristics of males and varying the coefficients, the differential was −1.0. One interpretation is that the Navy slightly favored females, but differences in characteristics between males and females caused men to be more likely to be promoted.

The corresponding differentials during the war period are 8.7 percentage points (actual), 3.8 percentage points (varying characteristics), and 5.3 percentage points (varying coefficients). Thus, the actual gap at E5 between men and women increased because the Navy apparently went from favoring women to favoring men and the average characteristics of women became less attractive relative to those of men.

We observe a qualitatively similar pattern for E4, but a strikingly different one for E6. The E6 differentials were −3.2 percentage points (actual), −2.4 (varying characteristics), and −0.7 (varying coefficients) during peace; and are −0.8, 1.4, and −2.2 during war. Thus, it appears that the Navy favored E6 women during peace and even more so during war. However, women had relatively more attractive characteristics during peace than during war. The net effect is that E6

women were much more likely than men to be promoted during peace but only slightly more likely during war.

For E5, men were 0.9 percentage point more likely to stay in the Navy than women based on the actual probabilities during peace. Using men's coefficients and varying the characteristics results in the same differential, 0.9. Using male characteristics, and varying the coefficients, the differential is eliminated. Corresponding differentials during war are 1.4 percentage points (actual), 1.2 percentage points (varying characteristics), and 0.1 percentage points (varying coefficients). Thus, the pattern of differentials does not vary much over time.

C. Effects of Specific Variables on Promotion and Retention

To learn how specific variables affect the probabilities, we conduct simulation experiments based on a typical sailor or base case in the Administration skill group. The characteristics of our typical sailor are the overall sample means or the mode case. The typical sailor is married, a high school graduate, in pay grade E4, currently is on shore duty, has an AFQT of 56, 105.9 months of service, 31.6 months of time in rank, spent 42.7% of his or her Navy career at sea, is eligible for promotion, has a pass rate on the exam of 37.1%, has a base pay of $26,746, and has an estimated probability of civilian employment of 94.5%. In 1998, the base period, the ratio of Vacancies to Takers was 0.32, the civilian unemployment rate for 4.9%, and the annual GDP was $9,520 billion.

The columns in Table 7 show how the probabilities of promotion vary across racial and sex groups for our typical sailor. The rows in Table 7 show how the probability of promotion changes relative to the base case as we change one variable at a time. The first row shows the probabilities of promotion for the base characteristics. The number in the first column of the first row, 60.7% is the probability that a White male was promoted. The second column of the first row shows that a White female's probability of promotion was only 49.5%, or 11.2 percentage points less than for a White male. The third column shows that a Black male's probability was only 53.6%, or 7.1 percentage points less than for a White male.

Moving down the rows, we show how the promotion probability changes for a given race/sex combination as we change one variable at a time. The first row, the base case, of the first column, White male, shows that with the mean AFQT score, the sailor's probability of promotion is 60.7%. The second row shows that raising the sailor's AFQT score to 80 increases his probability of being promoted by 2.2 percentage points to 62.9%. The other columns show

that this increase in AFQT score raises each race/sex group's probability of promotion by 2.2 to 2.4 percentage points. Similarly, the third row shows that lowering the AFQT to 35 reduces the promotion probabilities for the various demographic groups, but by smaller absolute amounts than raising it. As was discussed earlier, due to the additional AFQT impact for females, in all cases the increase in the rate of promotion due to an increase in AFQT is larger for females.

Having some post high school education raises the probability of promotion by between 5.4 to 6.1 percentage points. As we are controlling for intelligence as measured by the AFQT, presumably a sailor with post high school education is rewarded because of some extra knowledge or better discipline that is associated with the extra education.

Being currently on sea duty lowers the probability of promotion by 0.2 percentage point for a White male. As we noted above, the share of time spent on sea duty has a nonlinear effect, rising up to 22%, and then falling. Increasing the share of time during one's Navy career spent at sea from the average of 42.7% to 64.1% ($\approx 1.5 \times 42.7\%$) decreases one's probability of promotion substantially. A White male's probability falls from 60.7% to 36.7%, a White female's probability drops from 49.5% to 28.7%.

As we have already noted, the probability of promotion fell substantially over the last half of the sample period. For a White male, the probability was 60.7% in 1988, 43.9% in 2002, and only 9.5% in 2007. For a Black female, the probability dropped from 42.4%, to 30.9%, to 4.9%. Similarly, the probability of promotion is lower at higher ranks. A typical White male's probability is 60.7% at E4, but only 34.1% at E5.

Retention probabilities also vary with characteristics to a lesser degree. A White male with the base characteristics had a probability of being promoted and retained in the Navy of 60.5% and a probability of not being promoted but retained of 39.0%, so his probability of remaining in the Navy was 99.5% (= 60.5% + 39.0%). The corresponding probabilities are 49.4%, 50.0%, and 99.4% for a White female and 53.5%, 46.2%, and 99.7% for a Black male. Thus compared to a White male, a White female and a Black male are less like to be promoted and stay and more likely to not be promoted and stay, so that the overall probability of staying is virtually the same as for the White male. Because sailors with all race and sex groups are almost certain to stay, these differences in the joint probabilities reflect primarily the differences in the probabilities of being promoted.

When conditions are bad in the civilian labor market, sailors are more likely to remain in the Navy. If the civilian unemployment rate increases from 4.9% to 6.3%, the probability that a White male remains rises by 0.2 percentage points if promoted and by 0.3 percentage points if not promoted. If that sailor's estimated individual probability of finding civilian employment falls from 94.5% to 75%, a White male's probability of remaining in the Navy rises by 0.1 percentage point if promoted and by 0.2 percentage point if not promoted. These quantitative effects are small because virtually all E4 sailors remained in the Navy under any circumstances in 1998. The quantitative effects are larger for more recent years, thought the qualitative effects are the same.

D. Changes over Time Due to Navy Policies and Civilian Labor Market Conditions

The probabilities of being promoted and staying in the Navy changed substantially over time. Table 8 compares various demographic groups' probabilities in two years. The first year, 1998, was one of peace in which economic conditions were excellent and the Navy was near its peak size. The second year, 2006, is a war year near the end of our sample when economic conditions were poor and the Navy had shrunk substantially.

In contrast to the last simulation experiment where we freeze all but one explanatory variable, we now use the actual Navy policy and economic condition variables for each of our two years for our typical E4 sailor. Across race and sex groups, the promotion probability dropped substantially from between 40% and 59% in 1998 to between 5% and 10% in 2006. The probability of remaining in the Navy increased moderately from between 76% and 88% in 1998 to between 83% and 92% in 2006. A key reason why the retention probabilities didn't plummet despite the lower probability of promotion is that civilian economic conditions were substantially worse in 2006 than in 1998.

We can decompose the shifts over time due to three groups of variables: Navy policy variables (pass rate, vacancies/takers, time in rank, current sea duty status, share of time on sea duty, and length of service in zone A), civilian economic conditions (unemployment rate, the individual's employment probability, and GDP), and time trends including the 9/11 dummy. In these experiments, we hold the E4 sailor's base personal characteristics (AFQT, marriage status, and so forth) constant and then use various combinations of Navy policy variables, civilian economic condition variables, and time trends for 1998 or 2006.

23

Table 9 shows our eight hypothetical experiments: each of three groups of variables can take on 1998 or 2006 values. The first row shows what happens if all the variables are set at their 2006 levels: a White male sailor's probability of promotion is only 9.9%, his unconditional probability of staying in the Navy is 88.3%, the conditional probability of staying if promoted is 92.4%, and the conditional probability if not promoted is 87.8%. Thus, having been promoted raised his conditional probability of staying in the Navy by 4.6 percentage points (= 92.4% – 87.8%). These simulations are examining hypothetical situations and hence do not correspond to actual observed patterns.

The second row shows the corresponding probabilities if all three groups of variables are set at their 1998 levels: 58.7%, 84.5%, 87.9%, and 79.6%. At 1998 levels, the sailor was more than 5 times as likely to be promoted, but his unconditional and conditional probabilities of remaining in the Navy were lower than in 2006.

We can assess the relative contributions of each group of variables on the probability of promotion by changing one group of variables at a time and comparing the results to those in row 1. In row 3 where the Navy policies are at their 1998 levels and the other variables are at their 2006 levels, the probability of promotion is 2 percentage points higher than when Navy policies are at their 2006 level (row 1). Changing only the civilian labor conditions (row 4) has no effect on the promotion probability because they do not depend on civilian labor conditions. If we keep the Navy policy variables and labor market conditions at their 2006 level but set the time trends to their 1998 level (row 5), the promotion probability rises by more than 5-fold to 54.4%. The time trend variables capture the size-of-the-Navy effect, which is not included in the Navy policy variables. The Navy was at its peak size in 1998, and as a consequence, promotion rates were high. If we change the Navy policies and the time trends to their 1998 level (row 7), the probability of promotion is 58.7%, or only 4.3 percentage points higher than from changing the time trends alone. Thus, changing the Navy policies other than the size of the Navy back to the "good old days" would have had a relatively small effect on promotion and retention probabilities.

We can similarly conduct hypothetical simulation experiments concerning the effects of the groups of variables on retention probabilities, where civilian labor market conditions play a prominent role. If civilian labor market conditions were at their excellent 1998 levels while the Navy policies and time trends were at their 2006 levels (row 4), the unconditional retention

probability would have been 5.3% instead of the observed 88.3%. That is, given the very low promotion rates in 2006, if the sailor had decent opportunities in the civilian labor market, he would have almost certainly have left.

Changing only the time trends to the 1998 level (row 5) would have increased the retention probability from 88.3% to 99.9%. Thus, any increased retention due to patriotism in the post-9/11 era was more than offset by other changes over time including being in wartime conditions. If both labor market conditions and time trends were at their 1998 level (last row), the probability would have been 83.3%, only slightly lower than the observed 2006 probability of 88.3%. Thus, these simulation experiments indicate that Navy policies contribute much less to keeping sailors in the Navy than did civilian labor market conditions.

VI. Conclusions

Our promotion and retention study is the first to simultaneously examine the separate decisions of the employer and the employees while controlling for employees' abilities using an intelligence or ability test score. This model allows us to examine two important policy questions: Does the Navy treat various demographic groups unequally? Do the Navy's policies have an important effect on retention?

We have very clear-cut results concerning race. Despite the Navy's elaborate controls to ensure fairness, the probability of promotion varies statistically and significantly across races and by sex. Blacks, Hispanics, and other races were less likely to be promoted and more likely to stay in the Navy than Whites. Though we provide here detailed analysis of only one basic skill group, our results are robust and qualitatively similar across all of the skill groups.

The annual probabilities of promotion and retention could differ across racial and sex for three reasons. First, demographic groups could be treated differently by the Navy in the sense that people with the same characteristics but who differ in terms of race or sex have different probabilities (that is, the coefficients on individuals' characteristics are the same across demographic groups). Second, these groups could have different mixes of observed characteristics such as education and experience. Third, there could be differences in unobserved characteristics across the demographic groups.

Differences in coefficients (the first hypothesis) play roughly twice as large a role as the difference in observed characteristics (the second hypothesis) in explaining the overall difference in promotion probabilities between Whites and other races. The difference in coefficients is most

pronounced for Hispanics. We cannot explicitly examine the third hypothesis. However, because our bivariate probit analysis includes an objective ability measure, the AFQT score, as well as a large number of other observed characteristics, it is relatively unlikely that racial and sex differences in promotion rates reflect unmeasured ability differences across demographic groups[13].

The gap in promotion probabilities between Whites and other races increased moderately from before to after 9/11. The part of the differentials due to Navy actions (as captured by the coefficients) has shrunk over time, so that the increase in the actual differential is due to changes in the relative characteristics of the various groups.

The results concerning the treatment of the sexes vary across pay grades. Males are substantially more likely to be promoted than females in pay grades up to E5. During the war years, the actual gap at E4 and E5 between men and women increased both because of changes in the sex coefficients and because the average characteristics of women became less attractive relative to the Navy than those of men. In contrast, E6 women did better than men during peace and even more so during war. However, these women had relatively more attractive characteristics during peace years than during war years. The net effect is that E6 women were much more likely than men to be promoted during peace but only slightly more likely during war. Females are more likely than males to stay in the Navy at E4, but are less likely at E5 and E6.

Individual characteristics matter, but no single characteristic other than race or sex plays a dominant role. For example, intelligence or ability as measured by the AFQT score plays a relatively small role in determining promotions. Raising the typical E4 sailor's score from the 55th percentile to the 80th increases the promotion probability 2.2 percentage points.

Higher rates of promotion slightly increase the odds that a sailor remains in the Navy. Since the late 1990's, the Navy has been shrinking, despite war time conditions during much of this period. Apparently as a consequence, the rate of promotion has plummeted: For a typical White male E4 sailor, the probability of promotion fell from 58.7% in 1998 to 9.9% in 2006.

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[13] We note that AFQT does not capture all of the unobserved abilities. For example, verbal fluency, writing ability, sociability, etc., which are all related to promotions in civilian jobs, are not captured by AFQT and education (at the HS level).

Nonetheless, retention rates have remained relatively high in recent years because of the increasing lack of opportunities—particularly for minorities—in the civilian labor market and the relative increase in the Navy pay relative to civilian wages

When conditions are bad in the civilian labor market, sailors are more likely to remain in the Navy. For most of the time period, this effect was quantitatively small because almost everyone remained in the Navy. Now, these conditions may matter more. Our model does a good job of predicting the actual observed retention rate in 2006 of 88.3% based on actual Navy policies and the poor labor market conditions in that year. However, if we conduct the hypothetical experiment where we change the civilian labor market conditions to their excellent 1998 levels but keep all other 2006 conditions (such as the wars) including Navy policies the retention probability would have fallen significantly. That is, given the very low promotion rates in 2006, if the sailors had good opportunities in the civilian labor market, most of them would have left. These simulations show that Navy policies (other than the size of the Navy) contribute much less to keeping sailors in the Navy than do civilian labor market conditions. Consequently, if the Navy remains small and has a low probability of promotion, it faces the risk that when civilian economic conditions improve, the Navy could lose many of its enlisted sailors upon the expiration of their tours of duty. To avoid that outcome, the Navy may have to raise the promotion rate, pay substantial re-enlistment bonuses, continue to increase the Navy's relative wage, or take other financially costly actions.

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Table 1. Means (%) for the Administration Skill Group

	All	White	Black	Hispanic	Other	Male	Female
Promoted	31	34	29	29	29	31	31
Stay in the Navy	93	91	94	94	94	93	92
Promoted/Stay	26	27	25	26	25	26	26
Promoted/Leave	5	7	4	3	4	5	5
Not Promoted/Stay	67	64	69	69	69	67	66
Not Promoted/Leave	2	2	2	3	2	2	3
E4, pay grade	26	23	27	27	25	23	32
E5	36	35	36	36	34	36	34
E6	31	34	30	29	34	28	25
Zone A	37	37	34	37	37	33	45
Zone B	26	24	27	27	27	27	25
Zone C	23	24	24	23	25	26	18
Zone D	13	15	13	12	11	14	12
Black	37	0	100	0	0	34	44
Hispanic	11	0	0	100	0	11	12
Other	9	0	0	0	100	9	8
Female	30	25	35	31	28	0	100
AFQT	55	63	47	53	54	56	52
High School Diploma	88	87	92	86	80	87	91
Post High School	7	7	5	6	14	7	6
Married	59	61	56	60	61	64	47
Pass	39	41	36	38	43	39	39
Sea Duty	51	50	52	49	47	49	54
Share Sea Duty	45	44	44	49	48	47	40
Probability of civilian employment	94	96	92	95	96	95	93
Vacancies/Takers ($\times$ 100)	32	33	31	30	35	32	32
Time in Rank (months)	30	31	29	26	29	31	27

Notes: All means are percentages except for time in rank (months) and Vacancies/Takers, which is multiplied by 100. AFQT is the Department of Defense test of ability. Zone A: 0 to 6 years and 1 month of service. Zone B: 6 year, 2 months to 10 years, 1 month. Zone C: 10 years, 2 months to 15 years. Zone D: 16 to 20 years. Zone E (not reported): more than 20 years. Averages are based on 53,556 observations.

Table 2. Frequencies (%) **by Pay Grade**

	Promoted	Stay	Not Promoted, Stay	Promoted, Stay	Not Promoted, Leave	Promoted, Leave
E3	79	99	20	79	1	~0
E4	38	96	59	37	3	1
E5	23	93	75	18	2	5
E6	23	89	76	13	1	1

Note: Due to rounding, the last four elements of each row may not add to 100.

Table 3. Bivariate and Probit Estimation Results for Administration

	Bivariate Probit		Probit
Variable	Promote	Retain	Promote and Retain
Constant	**1.0242**	2.9872	**7.6461**
AFQT	**.0022**	**-.0043**	**.0047**
High School Diploma	.0124	**.1799**	**.1686**
Post High School	**.1570**	.1364	**.2356**
Sea Duty	-.0095	**.5360**	**-.2162**
E4 (Pay Grade)	**-.8628**	-.0932	**-1.5025**
E5	**-1.5512**	**.9526**	**-3.1581**
E6	**-1.9727**	**2.5525**	**-4.0929**
Black	-.0660	**-.5381**	-.0736
Hispanic	.1632	-.3606	.2237
Other	.0411	**-.5541**	.1763
Female	-.1201	.2005	-.0381
Black × E4	**-.1510**	**.5831**	**-.1694**
Hispanic × E4	**-.1927**	.3252	**-.2017**
Other × E4	**.0046**	**.4679**	-.0177
Female × E4	**-.2448**	-.1724	**-.1511**
Black × E5	-.0486	**.7216**	.1049
Hispanic × E5	**-.2564**	.3825	-.0957
Other × E5	-.0464	**.7212**	.0888
Female × E5	**-.2281**	**-.3139**	**-.2519**
Black × E6	-.0960	**.8399**	**.3224**
Hispanic × E6	**-.2498**	**.6189**	-.0177
Other × E6	-.1635	**.9129**	.0351
Female × E6	.0456	-.2875	**-.2249**
September 11, 2001	-.0357	.0458	**1.6997**
Peace time trend (before 9/11)	**-.1922**	.2386	-.1056
Peace trend squared	**.0301**	-.0422	**.0613**

War time trend (after 9/11)	**-.4823**	**-.6293**	**-.4028**
War trend squared	**.0313**	**.0515**	**.0674**
Pass	**.7354**		**1.0979**
Vacancies/Takers	**.3145**		**1.2254**
Vacancies/Takers Squared	**-.0129**		**-1.3283**
Share Sea Duty (fraction)	**.6779**		**.3844**
Share Sea Duty Squared	**-1.5162**		**-.3392**
Black × AFQT	-.0000		**-.0029**
Hispanic × AFQT	-.0018		-.0021
Other × AFQT	-.0003		-.0019
Female × AFQT	**.0027**		**-.2249**
Black × Peace trend	**.0919**		.0829
Black × Peace trend squared	**-.0182**		**-.0182**
Black × War trend	**.1168**		**.0999**
Black × War trend squared	**-.0184**		**-.0161**
Hispanic × Peace trend	.0228		.0474
Hispanic × Peace trend squared	.0014		-.0118
Hispanic × War trend	.0471		-.0074
Hispanic × War trend squared	-.0036		-.0014
Other × Peace trend	.0168		.0117
Other × Peace trend squared	-.0055		-.0075
Other × War trend	.0176		.0039
Other × War trend squared	-.0026		-.0058
Female × Peace trend	.0624		.0342
Female × Peace trend squared	-.0123		-.0007
Female × War trend	-.0643		.0452
Female × War trend squared	**.0199**		.0003
Married		**.2559**	**.1433**
Married × Sea Duty		**-.1675**	**.0327**
Zone A		**-5.2517**	**1.8162**

Zone B		**-5.1929**	**2.4689**
Zone C		**-3.8933**	**3.5990**
Zone D		**6.3486**	**8.5744**
Length of Service × Zone A		**.0363**	**.0105**
Length of Service × Zone B		**.0364**	.0001
Length of Service × Zone C		**.0251**	**-.0075**
Length of Service × Zone D		**-.0289**	**-.0346**
Time in Rank		**.0109**	**.0234**
Base pay		**-.4902**	**.0776**
GDP		**1.1552**	**-1.0627**
Unemployment. Rate (%)		**.6669**	**-.1064**
Probability of civilian employment (fraction)		**-1.8010**	**-2.3376**
Promoted		**.9120**	
Rho	**-.3575**		

Notes: A bold coefficient indicates that the p-value is less than 0.05. There are 53,556 observations. The log-likelihood statistic is -31,148 for the bivariate probit and -18,598 for the probit. The probit McFadden pseudo R^2 is 0.39.

The Bivariate Probit Prediction Table

Actual over (Fitted values in parentheses)

	Promoted		
Retained	0	1	*Total*
0	1,084 (2,126)	2,700 (353)	3,784 (2,479)
1	35,818 (41,149)	13,954 (9,928)	49,772 (51,077)
Total	36,902 (43,275)	16,654 (10,281)	53,556 (53,556)

The Probit Prediction Table

(1 = Promoted and Retained)

Actual Value	**Predicted Value**		
	0	1	Total
0	36,843 (68.8%)	2,759 (5.2%)	39,602 (73.9%)
1	5,374 (10.0%)	8,580 (16.0%)	13,954 (26.1%)
Total	42,217 (78.8%)	11,339 (21.2%)	53,556 (100%)

Table 4. Promotion Probabilities by Pay Grade, Race, and Sex

	White	Black	Hispanic	Other	Male	Female
Pre-9/11						
E4	56.7	47.9	51.1	55.3	54.0	49.7
E5	37.6	33.7	31.9	37.3	36.0	34.0
E6	40.6	33.6	34.9	35.7	36.4	39.6
Post-9/11						
E4	45.9	37.4	37.0	40.0	43.1	37.1
E5	29.4	23.2	20.7	24.9	28.2	19.5
E6	29.9	21.6	20.2	24.8	25.5	26.3

Table 5. Predicted Probabilities (%) by Race for E5

		Pre-9/11		Post-9/11	
Coefficients	Characteristics	Promotion	Retention	Promotion	Retention
White	**White**	**37.6**	**92.7**	**29.4**	**91.8**
White	Black	36.5	95.0	25.1	94.4
White	Hispanic	43.0	95.2	24.7	93.9
White	Other	38.2	96.1	25.3	95.1
Black	White	35.0	92.6	27.1	91.7
Black	**Black**	**33.7**	**95.0**	**23.2**	**94.3**
Black	Hispanic	34.3	94.9	18.8	93.8
Black	Other	37.7	96.2	23.4	95.1
Hispanic	White	26.6	92.2	24.1	91.6
Hispanic	Black	33.4	91.1	21.3	94.3
Hispanic	**Hispanic**	**31.9**	**94.8**	**20.7**	**93.8**
Hispanic	Other	32.8	95.9	21.2	95.0
Other	White	36.6	92.6	28.9	91.7
Other	Black	33.4	95.0	24.7	94.4
Other	Hispanic	36.3	95.0	24.4	93.9
Other	**Other**	**37.3**	**96.1**	**24.9**	**95.1**
Overall Sample for E5		**35.5**	**94.1**	**25.7**	**93.2**

Table 6. Predicted Probabilities (%) **by Sex**

Coefficients	Characteristics	Pre-9/11		Post-9/11	
		Promotion	**Retention**	**Promotion**	**Retention**
E4					
Male	**Male**	**54.0**	**96.2**	**43.1**	**95.2**
Male	Female	48.9	96.7	44.2	95.9
Female	Male	55.1	96.2	36.9	94.9
Female	**Female**	**49.7**	**96.7**	**37.1**	**95.6**
E5					
Male	**Male**	**36.0**	**94.3**	**28.2**	**93.6**
Male	Female	33.5	93.5	24.4	92.4
Female	Male	37.0	94.3	22.9	93.5
Female	**Female**	**34.0**	**93.5**	**19.5**	**92.2**
E6					
Male	**Male**	**36.4**	**90.3**	**25.5**	**89.6**
Male	Female	38.8	86.1	24.1	84.9
Female	Male	37.1	90.3	27.7	89.7
Female	**Female**	**39.6**	**86.2**	**26.3**	**85.1**

Table 7. Promotion Simulations (Percentages)

	White Male	White Female	Black Male	Black Female	Hispanic Male	Hispanic Female
Base Case	**60.7**	**49.5**	**53.6**	**42.4**	**59.2**	**48.0**
AFQT=80	62.9	51.7	55.9	44.6	61.5	50.2
AFQT=35	59.2	47.8	52.0	40.8	57.7	46.3
Post HS	66.1	55.1	59.3	48.0	64.7	53.6
Sea Duty	60.3	49.0	53.2	41.9	58.8	47.5
1.5×Share Sea Duty	36.7	28.7	31.4	24.0	35.6	27.6
1.5×Vacancies/Takers	61.7	50.5	54.7	43.4	60.3	49.0
2002	43.9	36.9	37.4	30.9	42.5	35.6
2007	9.5	7.3	6.5	4.9	9.2	7.0
E5	34.1	25.0	31.3	22.6	30.5	21.9

Notes: Base characteristics: married, high school graduate, E4, on shore duty, share of career at sea = 42.7%, AFQT=56, service = 105.871 months, time in rank = 31.61 months, eligible for promotion, pass rate = 37.1%, base pay = \$26,746, estimated probability of civilian employment = 94.5%, year = 1998, vacancies/takers = 0.318, civilian unemployment rate = 4.92%, and GDP = \$9,520 billion.

**Table 8. Promotion and Retention Simulations** (Percentages)

	White Male	White Female	Black Male	Black Female	Hispanic Male	Hispanic Female
1998						
Promotion	58.7	47.2	51.8	40.4	57.3	45.8
Retention	84.5	82.7	88.1	86.6	77.8	75.7
Retention if promoted	87.9	87.4	91.4	91.0	82.3	81.6
Retention if not promoted	79.6	78.5	84.5	83.7	71.8	70.6
2006						
Promotion	9.9	6.5	7.3	4.6	9.5	6.2
Retention	88.3	88.3	91.7	91.9	82.9	83.0
Retention if promoted	92.4	91.8	94.7	94.2	88.2	87.4
Retention if not promoted	87.8	88.0	91.5	91.7	82.3	82.7

Table 9. Groups of Variables Simulations (Percentages)

Navy Policies	Civilian Labor Market	Time Trends	Promotion	Retention	Retention if Promoted	Retention if not Promoted
2006	2006	2006	9.9	88.3	92.4	87.8
1998	1998	1998	58.7	84.5	87.9	79.6
1998	2006	2006	11.9	88.8	93.0	88.3
2006	1998	2006	9.9	5.3	7.0	5.1
2006	2006	1998	54.4	99.9	99.9	99.9
1998	1998	2006	11.9	5.6	7.6	5.3
1998	2006	1998	58.7	99.9	99.9	99.9
2006	1998	1998	54.4	83.3	87.3	78.5

Figure 1. Probability of Retention by Year and Pay Grade

(a) Probability that a Sailor is Promoted and Stays
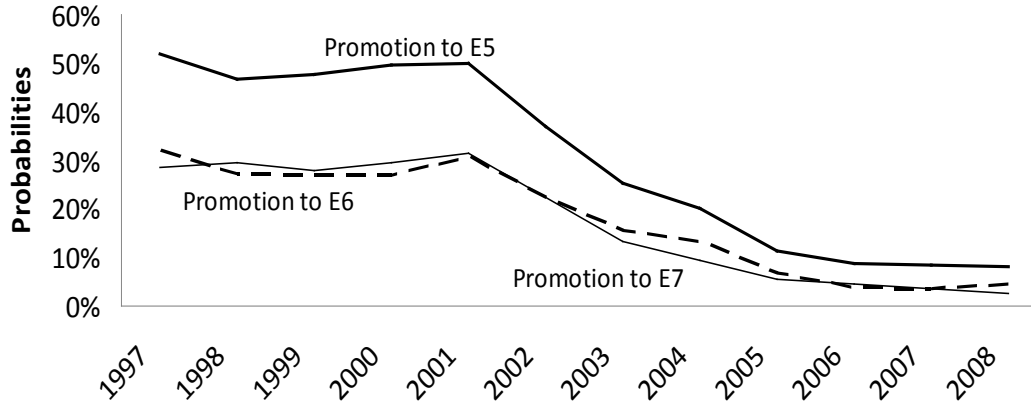
(b) Probability that a Sailor is Not Promoted and Stays