The Economy and Enlisted Retention in the Navy

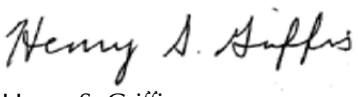
Volume II: Technical Appendixes

Jane K. Pinelis • Jared M. Huff

DRM-2014-U-007302-Final
June 2014

CNA
ANALYSIS & SOLUTIONS

Approved for distribution: June 2014



Henry S. Griffis
Defense Workforce Analyses Team
Resource Analysis Division

This document contains the best opinion of CNA at the time of issue.
It does not necessarily represent the opinion of the Sponsor.

Distribution unlimited. Specific authority: N00014-11-D-0323.
Copies of this document can be obtained through the Defense Technical Information Center at www.dtic.mil
or contact CNA Document Control and Distribution Section at 703-824-2123.

Contents

This page intentionally left blank

Introduction

In the main volume of this report, we estimate the relationship between the state of the civilian economy and Navy retention. Much of the technical detail of that analysis was excluded for brevity and is instead shown and discussed here.

This volume of appendixes begins with a discussion of the fundamental underlying retention model that we estimate. There are three main choices, each with its strengths and weaknesses. As we discuss, the peculiarities in civilian economy greatly drove our ultimate choice of model.

We then discuss the novel input in our retention model: the economic components discussed at length in the main document. We particularly emphasize the components' stability over time. This is important because we anticipate these components being used to predict retention in the future. As such, ongoing validity of the estimated relationship between the economic variables is a desirable property.

In the third section, we discuss the other variables that were included in the retention regressions. This is important both to help the reader understand what we are "controlling for" in our regressions and to ensure that replication is feasible.

The fourth section highlights estimates that were not reported in the main paper. These estimates fall into two categories: those that explore the relationship between interactions of the (independent) economic components and retention and those of noneconomic variables that affect retention. The latter, in particular, should be viewed as estimated correlations and not causal estimates; our focus was mainly on the careful characterization of the civilian economy.

This appendix concludes with estimates of the sensitivity of our results to the inclusion and exclusion of time periods in which the Navy's force-shaping policy "Perform-to-Serve" (PTS) was in use. We find that the estimated relationship between the economy and retention

becomes generally unexplainable during this time period. This suggests that the policy separated a sailor's willingness to reenlist from his or her actual reenlistment decision; instead, retention was being driven by factors that are thus far unobservable to the researcher.

Appendix A: Structural or reduced-form estimates?

Retention models usually assume that servicemembers consider lifetime earnings when making their reenlistment decisions. The main ways to treat this assumption are with either structural or reduced-form estimates. Structural estimates explicitly model a sailor's process of decision-making throughout his or her remaining military career. This can be modeled as a series of decisions:

- If the person leaves the military this period, he or she gets civilian pay for the rest of his or her life.
- If the person reenlists this period, he or she receives military pay and then gets to choose between reenlistment and civilian life at some point in the future.
  - — At each of these future points, this process is repeated.

How this calculation is handled in practice forms the major distinction between Dynamic Models of Reenlistment (DRM) and Annualized Cost of Leaving (ACOL) models. ACOL makes a simplifying assertion (i.e., that the expectation of the maximum of the wage paths is equal to the maximum of the expected wage paths; see [1]) that DRM does not. In the presence of uncertainty, this assumption is false; however, the assumption makes ACOL *much* more tractable in practice. DRM is occasionally noted as failing to achieve convergence without additional simplifying assumptions [1]. In support of this point, the relatively sparse number of variables in even the most recent DRM analyses is telling;[1] we were unable to find a single set of DRM estimates that included the unemployment rate. Readers interested in a more detailed comparison between the relative strengths and weaknesses of ACOL and DRM are directed to [1, 2, and 3].

[1] In general, including fewer variables makes achieving convergence easier/feasible.

Pure reduced-form estimates eschew this calculation entirely and usually model the retention decision as a function of variables that can be observed in the present. The relative attractiveness of the military is often captured in a ratio of military pay to expected civilian pay for the upcoming year.

Note that ACOL and DRM calculations require, at a minimum, accurate measures of sailors' expectations of:

- Current and future military pay
- Current and future civilian pay
- Ability to stay in the military in future periods if staying in today

The first requirement is relatively straightforward; we include current military pay in our analysis. Furthermore, a reasonable assumption could likely be made in regard to the growth rate of basic pay and allowances across time.

The second requirement—current and future civilian pay—is an important complication, particularly during a weak civilian economy. In previous studies, researchers have identified how much civilians, who are similar to people in the dataset, are paid at their civilian jobs. They use this as the expected pay on leaving the military. In past studies, this has been a reasonable assumption. But, when looking at an economic event, such as a recession, this becomes a poor assumption for several reasons. First, people who are already employed as civilians do not face the job search process that the average new veteran will face. Given that the average time of unemployment in our data between 2009 and 2012 reached more than 40 weeks, the average sailor could expect to forgo up to one-third more of his or her first-year civilian salary than during normal economic times while waiting on employment. Second, recent research has shown that new high school and college graduates who enter the job market during a recession or periods of high unemployment suffer sizable and long-lasting negative wage shocks compared with those who enter the workforce during nonrecessionary times [4 and 5]; some of the wage loss is due to initial "underemployment." If those who leave the military suffer similar wage loss, the use of the wages of the currently employed becomes problematic. Furthermore, the prospect of underemployment may reduce a sailor's taste for holding a civilian

occupation. Unfortunately, these wage effects cannot be predicted on an individual basis using cross-sectional data: representative estimates of the wages of new civilian hires are not collected by civilian or government agencies (such as the Bureau of Labor Statistics (BLS)); the previous studies relied on small datasets collected in the 1980s and 1990s.

The third requirement, the ability to stay in the military in future periods if staying today, has also been a key assumption of past ACOL models [6]. The implementation of Perform-to-Serve (PTS) between 2009 and 2012, however, invalidates this assumption. Furthermore, because the total number of people who wanted to reenlist but who were denied under PTS is unavailable, the "correct" probability of being able to stay in the Navy if desired is unknown and was probably unknown to the sailor.

In the end, we view our decision about our modeling choice as being between three possibilities:

- Overestimate (perhaps dramatically) available civilian opportunities and make an untestable guess about how PTS affected sailors' internal probabilities of being able to remain in the military in the future.
- Make an untestable guess about how much lower civilian opportunities were in actuality than were measured and make an untestable guess about how PTS affected sailors' internal probabilities of being able to remain in the military in the future.
- Use a contemporaneous reduced-form estimation that avoids using either of these but has more limited applicability. In particular, the reduced-form estimates are less likely to be valid for variables whose future values are well outside those in our sample (such as A-cell percentage; see our discussion in the main report about this issue).

In this analysis, we choose to accept the limited applicability of reduced-form estimates to avoid making strong (and implausible) assumptions about sailor expectations and outside wage offers during the most recent economic downturn.

Appendix B: Stability of economic indices over time

A potential hazard resulting from the ongoing use of principal components using static coefficients is the possibility that the underlying relationship between variables may change over time. We address this issue here in two ways. First, we show that our components have been relatively stable across time. Second, we use the Bureau of Economic Analysis (BEA) quinquennial update of historical real GDP values (and the values of other "real" variables) to test the stability of the estimated principal components to underlying value changes.

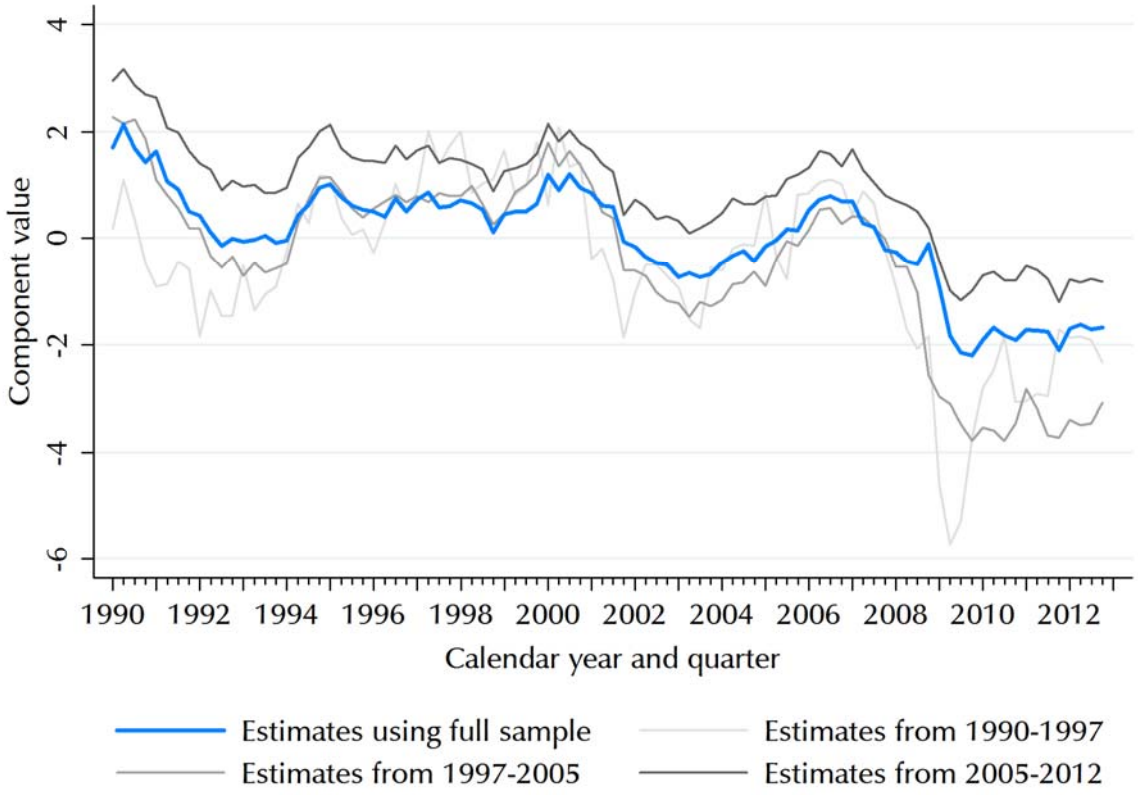
To show that our variables coalesce into the same indices over time, we divide our economic data into three, roughly equal periods: 1990–1997, 1998–2005, and 2006–2012. We use principal components analysis on quarterly observations of our 11 variables and estimate three principal components in each of the three periods, as well as on our sample as a whole. In each case, we restrict the number of components to three.

Once we have estimated the relationship between individual variables and the indices for each of the three time periods, we apply these estimates to all years in our sample. This allows us to identify whether, for instance, the unemployment and Treasury rate component from 1990–1997 would identify the same peaks and troughs as that estimated in 2006–2012.[2]

We begin by showing the stability of the unemployment and Treasury rate component in figure 1.

2. While we find the similar indices (e.g., the unemployment and Treasury rate component) across time, this was not a constraint of the model. In theory, the principal components analysis could have identified completely unrelated indices in each time period.

Figure 1. Across-time stability of the unemployment and Treasury rate component



As figure 1 shows, the unemployment and Treasury rate component is fairly stable: the biggest deviation occurs between 1990 and 1997, but even here the correlation between the component estimated in this period and the one estimated using the full sample exceeds 0.8.

The other two components are also stable across time. Figure 2 shows the production growth component.

We again see that the estimates obtained in different time periods follow a similar trend. All track closely and show notable dips in the early 1990s, early 2000s, and late 2000s.

Finally, figure 3 shows the stability of the price index component. As in the other two cases, applying estimates from different time periods to the full range of the data resulted in indices that are all highly correlated.

Figure 2. Across-time stability of the production growth component

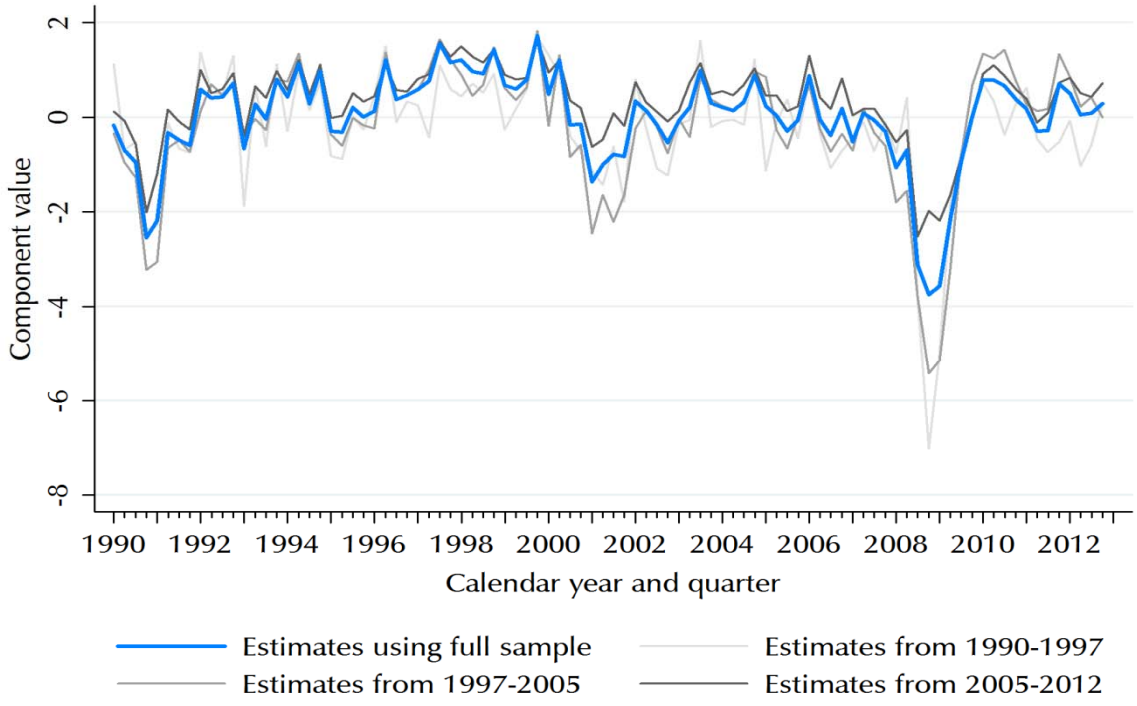
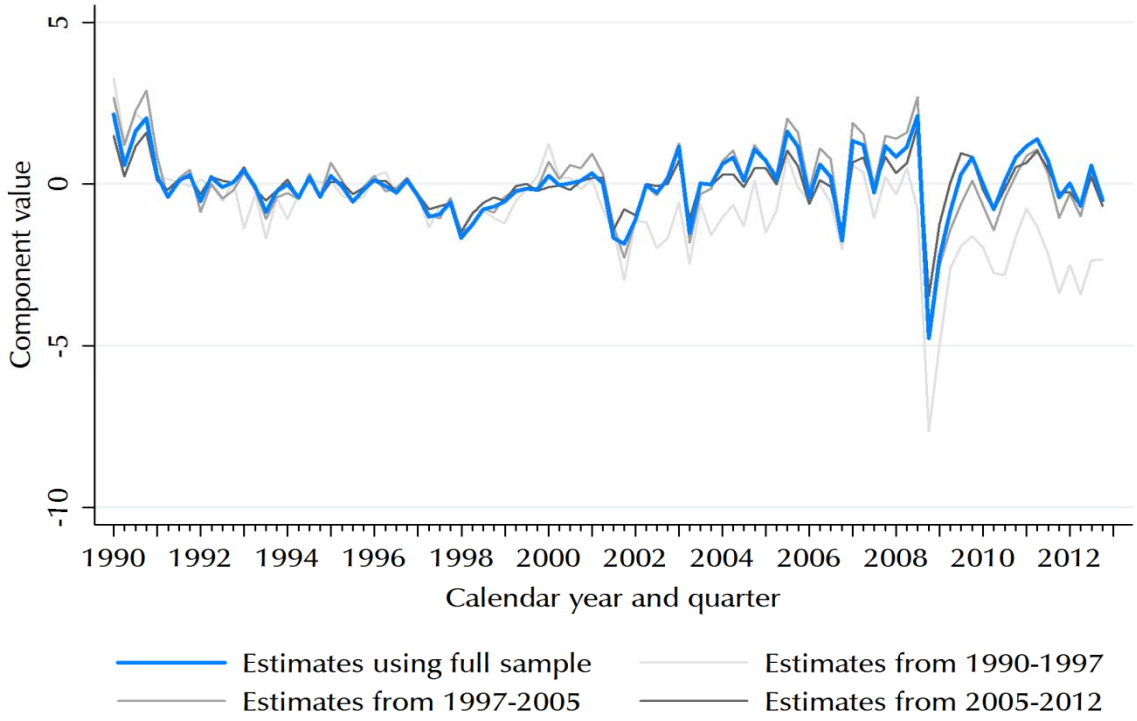


Figure 3. Across-time stability of the price index component



In this section of the appendix, we have shown that the calculated components are stable across the time period used in our sample. This is important because a stable past relationship suggests (but certainly does not guarantee) a stable future relationship. This, in turn, supports the validity of using the components defined in this paper to project retention in the future.

Appendix C: Variable list and summary statistics

Sailors' retention decisions are based not just on the opportunities outside the Navy, as measured by the civilian economy, but also on a number of personal military and demographic characteristics. We thus complete the explanatory portion of our retention model by incorporating relevant information about the sailors themselves. This appendix provides a complete list of our variables, as well as summary statistics for variables whose marginal effects were discussed in the main portion of this report or later in the technical appendix.

Our econometric retention model included the following variables, in addition to the economic indices:

- Selective reenlistment bonus (SRB)
- Months of sea duty
  - Ever
  - In past 24 months
    - Separate indicator for 0 month[3]
    - Separate indicator for 24 months
- Paygrade at decision
- Months in the Navy's delayed entry program (DEP) before initial enlistment
- Indicator for EMC change in past 12 months

3. As table 1 shows, over 11 percent of the Zone A men in our sample have 0 month of sea duty in the previous two years. This is due in part to disproportionate shares of Hospital Corpsmen, Cryptologic Technicians, and men with military spouses.

- Armed Forces Qualification Test (AFQT) (as well as AFQT squared and cubed)
- Quality measures:
  - — Fast promotion to E-5 (top 25 percent of their Enlisted Management Community (EMC), based on their time in rate at E-4)
  - — Tier 1 education with AFQT less than 67
  - — Technical quality (high school diploma graduate (HSDG) with AFQT between 67 and 80)
  - — Highest quality (HSDG with AFQT 80 or greater)
- Age (as well as age squared and cubed)
- Number of children
  - — Indicators for positive/negative change in past 12 months
- Married to military or nonmilitary spouse
- Promoted, divorced, or married in previous year
- Race and Hispanic indicators
- Number of changes in recorded Unit Identification Code (UIC) state
- Demoted: ever or within previous year
- Initial term length
- Military pay (basic plus Basic Allowance for Housing (BAH)/ Basic Allowance for Subsistence (BAS))
- Months in UIC and paygrade
- Months deployed in last two years

The following tables show the mean values for the variables whose marginal effects are shown either in the main paper or later in this technical appendix document. Table 1 shows the means for Zone A sailors, while table 2 shows the same for Zone B sailors.

Table 1. Selected summary statistics of Zone A sailors

Statistic	Men	Women
SRB	1.2	0.7
Months of sea duty in past 24 months	19.3	10.7
0 month of duty in past 24 months	11.7%	42.0%
24 months of sea duty in past 24 months	61.1%	26.7%
E-3	17.3%	21.9%
E-4	54.5%	55.6%
E-5	27.4%	22.2%
E-6	0.8%	0.3%
Months in DEP	5.0	4.9
EMC change in past 12 months	1.1%	0.9%
AFQT score	60.9	58.1
Fast promotion to E5	29.3%	28.6%
Tier 1 education with AFQT<67	56.1%	66.4%
Technical quality	19.6%	19.4%
Highest quality	18.8%	11.9%
Age	24.5	24.6
Number of children	0.3	0.4
Lost children in past 12 months	0.5%	1.8%
Added children in past 12 months	8.5%	13.5%
Married (nonmilitary spouse)	36.5%	20.1%
Married (military spouse)	2.9%	22.6%
Married in past 12 months	9.0%	10.7%
Divorced in past 12 months	1.2%	3.0%
Hispanic	12.6%	15.0%
Black	17.1%	27.6%
Number of observations:	525,535	89,925

Table 2. Selected summary statistics of Zone B sailors

Statistic	Men	Women
SRB	1.0	0.5
Months of sea duty in past 2 years	8.2	6.4
No sea duty in past 2 years	54.5%	62.6%
Full sea duty in past 2 years	22.3%	15.3%
E-3	0.8%	0.9%
E-4	18.2%	26.0%
E-5	59.3%	61.0%
E-6	21.1%	11.9%
E-7	0.5%	0.2%
Months in DEP	4.9	5.0
EMC change in past 12 months	1.1%	0.9%
AFQT score	60.3	57.7
Fast promotion to E5	26.5%	21.9%
Tier 1 education with AFQT<67	56.7%	67.6%
Technical quality	19.0%	18.4%
High quality	18.6%	11.7%
Age	28.7	28.5
Number of children	0.9	0.7
Lost children in past 12 months	1.1%	2.8%
Added children in past 12 months	13.3%	12.3%
Married (nonmilitary spouse)	64.4%	25.9%
Married (military spouse)	4.1%	25.5%
Married in past 12 months	6.9%	7.0%
Divorced in past 12 months	2.7%	4.3%
Hispanic	11.9%	14.0%
Black	21.3%	34.7%
Number of observations:	186,513	32,148

Appendix D: Additional regression results

Interactions between principal components

In the main report, we show the average relationships between each of the economic components and retention. Here, we document that these estimated relationships can depend on the value of the other components. This supports the results in the main document by further illustrating when changes in the economic components are likely to lead to larger or smaller changes in retention.

To begin, we consider two scenarios:

- First, we look at changes in the estimated relationship between retention and the unemployment and Treasury rate component when:
  - — The production growth component signifies a weak (component value of -1), moderate (0), and strong (1) economy
  - — The price index component signifies a weak (component value of -1), moderate (0), and strong (1) economy
- Second, we examine the correlation between retention and both the production growth component and the price index component.

For each, we define a weak and a strong economy as being a standard deviation below the mean and a standard deviation above the mean, respectively.[4] So, for a given component, we expect that roughly 17 percent of the months in our sample will be categorized as weak and 17 percent as strong. We categorize the remaining 66 percent as months with a moderate economy.

4. Recall that a component value of 1 is defined as 1 standard deviation above the mean and a component value of -1 is defined as 1 standard deviation below the mean.

To begin, we look at the how the estimated relationship between a 1-standard-deviation change in the unemployment and Treasury rate component and retention varies as the values of the other components vary. Our estimates are shown in table 3. We see that the estimated relationship is strongest when the economic environment otherwise looks strong; in essence, the largest correlations occur when the other components (initially) agree about the state of the economy. So, for instance, we see that a 1-unit change in the unemployment and Treasury rate component is expected to have twice the impact on retention when the production growth component is signaling a weak economy than when the production growth component is signaling a strong economy.

Table 3. Changes in the unemployment and Treasury rate component as other components change (Zone A men)

At levels of:	Weak	Moderate	Strong
Production growth component	**-4.7**	**-7.8**	**-10.6**
	[-5.0, -4.4]	[-8.0, -7.6]	[-10.9, -10.3]
Price index component	**-6.2**	**-8.4**	**-10.5**
	[-6.5, -5.9]	[-8.6, -8.2]	[-10.8, -10.2]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.

In table 4, we instead hold the unemployment and Treasury rate component constant at weak, moderate, and strong levels. We then estimate how the relationship between retention and the other components differs when the unemployment and Treasury rate component is at these levels. As in the previous table, we see that estimated changes in retention are greatest when the other components indicate a strong economy.

Table 4. Changes in other components as the unemployment and Treasury rate component changes (Zone A men)

Estimated relationship between retention and:	Level of unemployment and Treasury rate component		
	Weak	Moderate	Strong
Production growth component	**2.6**	**-0.7**	**-3.6**
	[2.3, 2.8]	[-0.9, -0.5]	[-3.9, -3.3]
Price index component	**3.9**	**1.5**	**-0.8**
	[3.6, 4.2]	[1.3, 1.7]	[-1.0, -0.5]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.

Tables 5 through 10 show that these results hold more generally: we see that a similar relationship holds for Zone A women as well as Zone B men and women as that found for Zone A men.

Table 5. Changes in the unemployment and Treasury rate component as other components change (Zone A women)

At levels of:	Weak	Moderate	Strong
Production growth component	**-5.1**	**-8.2**	**-11.0**
	[-5.8, -4.3]	[-8.7, -7.7]	[-11.7, -10.3]
Price index component	**-6.2**	**-8.6**	**-10.9**
	[-6.9, -5.4]	[-9.1, -8.1]	[-11.5, -10.3]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.

Table 6.Changes in other components as the unemployment and Treasury rate compon

Estimated relationship between retention and:	Level of unemployment and Treasury rate component		
	Weak	Moderate	Strong
Production growth component	**2.2**	**-1.0**	**-3.8**
	[1.7, 2.7]	[-1.4, -0.5]	[-4.6, -3.1]
Price index component	**3.1**	**0.4**	**-2.1**
	[2.4, 3.7]	[-0.1, 0.8]	[-2.8, -1.4]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.

Table 7. Changes in the unemployment and Treasury rate component as other components change (Zone B men)

At levels of:	Weak	Moderate	Strong
Production growth component	**-2.4**	**-3.5**	**-4.6**
	[-2.9, -2.0]	[-3.9, -3.2]	[-5.0, -4.1]
Price index component	**-3.2**	**-3.7**	**-4.1**
	[-3.7, -2.7]	[-4.0, -3.3]	[-4.6, -3.7]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.

Table 8. Changes in other components as the unemployment and Treasury rate component changes (Zone B men)

Estimated relationship between retention and:	Level of unemployment and Treasury rate component		
	Weak	Moderate	Strong
Production growth component	**1.4**	**0.3**	**-0.8**
	[1.1, 1.7]	[0.0, 0.6]	[-1.3, -0.3]
Price index component	**-0.2**	**-0.6**	**-1.1**
	[-0.6, 0.2]	[-0.9, -0.3]	[-1.6, -0.6]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.

Table 9. Changes in the unemployment and Treasury rate component as other components change (Zone B women)

At levels of:	Weak	Moderate	Strong
Production growth component	**-2.6**	**-4.0**	**-5.4**
	[-3.7, -1.5]	[-4.9, -3.2]	[-6.6, -4.2]
Price index component	**-2.8**	**-4.0**	**-5.2**
	[-4.0, -1.6]	[-4.8, -3.2]	[-6.1, -4.2]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.

Table 10. Changes in other components as the unemployment and Treasury rate component changes (Zone B women)

Estimated relationship between retention and:	Level of unemployment and Treasury rate component		
	Weak	Moderate	Strong
Production growth component	**1.9**	**0.4**	**-1.1**
	[1.2, 2.6]	[-0.3, 1.1]	[-2.4, 0.3]
Price index component	**-1.2**	**-2.4**	**-3.6**
	[-2.1, -0.2]	[-3.1, -1.7]	[-4.8, -2.5]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.

These tables all point to the same result: when all of the economic indicators are (independently) signaling that the economy is strong, changes in one of the indicators is likely to signal a greater change in retention than when all of the indicators are (independently) signaling a weak economy.

Personal characteristics

Table 11 shows military characteristics, and we discuss their relationships with retention in the order in which they are presented in the table.

We begin by estimating the relationship between SRBs and retention. We note that SRB has an inverse relationship with the retention environment. All else equal, when retention is more difficult, SRB rises. This confounding effect usually prevents researchers from interpreting SRB estimates as causal.

Our estimates suggest that a 1-point increase in the SRB multiplier is correlated with a 3.9-percentage-point increase in the Zone A retention rate for men and a 5.0-percentage-point increase in the Zone A retention rate for women.

Table 11. Relationship between military characteristics and retention (Zone A)

Variable	Men	Women
SRB	**3.9**	**5.0**
	[3.8, 4.1]	[4.6, 5.4]
E-3	**-28.4**	**-23.9**
	[-29.1, -27.6]	[-26.0, -21.8]
E-4	**-9.2**	**-10.0**
	[-9.7, -8.7]	[-11.3, -8.7]
E-6	**-3.1**	**-5.5**
	[-4.6, -1.6]	[-11.3, 0.3]
Months in DEP	**0.0**	**0.0**
	[0.0, 0.0]	[-0.1, 0.1]
EMC change in past 12 months	**23.4** [22.1, 24.7]	**32.8** [29.0, 36.6]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.
E-5 is the reference paygrade.

As noted in the main report, we find that sailors with a paygrade of E-5 have the greatest probability of reenlistment. Those in paygrade E-3 are substantially less likely to reenlist. These results hold for Zone A men and women. As we discuss next, this finding is important because the share of sailors who face the reenlistment decision at paygrade E-3 has risen in recent years.

We include months in the Navy's delayed entry program because research has shown that sailors who spend more time in DEP experience lower in-service attrition [7]. We find that, despite the correlation between months in DEP and active duty attrition, there is no relationship between months in DEP and retention rates.

Sailors who have recently changed their EMC are more likely to reenlist. We hesitate to assign a causal relationship to this variable, though. Because of PTS, it is possible that the decision to change EMC was made concurrently with the reenlistment decision, with the former decision preceding the latter.

Table 12 shows the estimated relationship between sailor quality metrics and retention. Once we control for other factors, the relationship between most of the quality measures in table 12 and the retention

rate is negative. Because the percentage of sailors who qualify as "fast promoters to E-5" has remained roughly constant over time, we expect that the improved recruit quality achieved during the recent economic downturn will lead to sailors who are, holding all else constant, less likely to reenlist.

Table 12. Relationship between sailor quality and retention (Zone A)

Variable	Men	Women
AFQT score	**-0.2** [-0.2, -0.2]	**-0.1** [-0.2, -0.1]
Fast promotion to E5	**7.0** [6.7, 7.3]	**7.6** [6.9, 8.4]
Tier 1 education with AFQT<67	**-3.3** [-3.9, -2.7]	**-1.5** [-3.6, 0.6]
Technical quality	**-3.2** [-3.8, -2.6]	**-0.4** [-2.6, 1.8]
High quality	**-3.4** [-4.2, -2.6]	**-0.8** [-3.5, 1.9]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.

Table 13 shows the relationship between a sailor's personal characteristics and the probability that he or she will reenlist. For both men and women, older recruits are less likely to reenlist. Both show retention rates that increase with the number of children. In fact, the estimated change in retention that is associated with adding an additional child under the age of 18 is similar to that of increasing SRB by 1 point—more so for men if the child is under a year.

Table 13. Relationship between other personal characteristics and retention (Zone A)

Variable	Men	Women
Age	**-1.0** [-1.1, -0.9]	**-1.2** [-1.5, -1.0]
Number of children	**4.1** [3.9, 4.4]	**5.5** [4.9, 6.1]
Lost children in past 12 months	**5.2** [3.4, 7.0]	**-3.5** [-5.8, -1.1]
Added children in past 12 months	**3.7** [3.2, 4.3]	**-0.1** [-1.2, 1.0]
Married (nonmilitary spouse)	**13.2** [12.9, 13.6]	**0.1** [-0.9, 1.0]
Married (military spouse)	**16.0** [15.3, 16.8]	**-0.7** [-1.6, 0.3]
Married in past 12 months	**9.7** [9.2, 10.1]	**4.0** [2.9, 5.1]
Divorced in past 12 months	**10.4** [9.3, 11.6]	**3.2** [1.5, 5.0]
Hispanic	**2.5** [3.2, 4.3]	**4.4** [-1.2, 1.0]
Black	**16.0** [15.7, 16.4]	**17.4** [16.7, 18.2]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.
Single is the reference marital status; white is the reference race.

Men and women seem to have different reenlistment behaviors in response to major life changes. For men, adding or losing a child and getting married, are strongly correlated with *higher* rates of Zone A retention.[5] For women, these relationships are either muted or negatively correlated with retention. Furthermore, being married is not

5. The net effect of getting divorced is negative, but the estimated relationship is weaker if the divorce happened in the year prior to the reenlistment decision.

consistently associated with a change in retention behavior for Zone A women; the estimated correlation between being married (to either a military or nonmilitary spouse) and retention is not statistically different from zero. Note that the estimated relationships are still relatively small even at the tails of the 95-percent confidence intervals. The converse holds for men, however; being married to either a military or non-military spouse is correlated with a higher rate of retention.

Tables 14, 15, and 16 show these estimates for Zone B sailors.

Table 14. Relationship between military characteristics and retention (Zone B)

Variable	Men	Women
SRB	**3.7** [3.5, 3.9]	**4.2** [3.4, 4.9]
Months of sea duty in past 2 years	**-0.9** [-1.0, -0.9]	**-0.4** [-0.6, -0.3]
No sea duty in past 2 years	**-23.3** [-24.3, -22.3]	**-14.1** [-16.5, -11.6]
Full sea duty in past	**11.1** [10.1, 12.2]	**12.0** [9.3, 14.7]
E-4	**-29.1** [-30.0, -28.2]	**-33.1** [-35.1, -31.1]
E-6	**7.6** [6.7, 8.5]	**14.3** [12.2, 16.4]
E-7	**13.8** [11.0, 16.5]	**23.0** [16.0, 30.1]
EMC change in past 12 months	**19.4** [16.9, 21.9]	**37.6** [29.8, 45.4]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.

Table 15. Relationship between sailor quality and retention (Zone B)

Variable	Men	Women
AFQT score	**-0.2** [-0.2, -0.1]	**-0.2** [-0.2, -0.1]
Fast promotion to E5	**0.9** [0.4, 1.5]	**-0.1** [-1.6, 1.4]
Tier 1 education with AFQT<67	**1.6** [0.6, 2.6]	**3.9** [0.3, 7.4]
Technical quality	**0.9** [-0.1, 2.0]	**3.3** [-0.3, 6.9]
Highest quality	**1.0** [-0.3, 2.3]	**5.1** [0.6, 9.6]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.

Table 16. Relationship between other personal characteristics and retention (Zone B)

Variable	Men	Women
Age	**-0.3** [-0.5, -0.2]	**-0.3** [-0.6, 0.0]
Number of children	**1.3** [1.0, 1.5]	**2.3** [1.6, 3.0]
Lost children in past 12 months	**1.7** [-0.4, 3.7]	**-5.6** [-8.7, -2.5]
Added children in past 12 months	**4.6** [3.9, 5.3]	**0.5** [-1.2, 2.2]
Married (non-military spouse)	**5.5** [5.0, 6.1]	**-1.6** [-3.0, -0.3]
Married (military spouse)	**7.4** [6.3, 8.5]	**1.2** [-0.2, 2.5]
Married in past 12 months	**7.3** [6.4, 8.2]	**1.9** [-0.2, 3.9]
Divorced in past 12 months	**5.6** [4.3, 7.0]	**5.3** [2.7, 7.9]
Hispanic	**1.3** [3.9, 5.3]	**2.7** [-1.2, 2.2]
Black	**6.7** [6.2, 7.3]	**10.1** [8.9, 11.4]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.

The Zone B results are similar to those of Zone A sailors; note in particular that higher paygrade at the reenlistment point is still correlated with higher retention.

This page intentionally left blank

Appendix E: Effects of Perform-to-Serve (PTS)

As we discuss in the main portion of our paper, one complicating factor for our analysis is the existence of Perform-to-Serve (PTS). This was a force-shaping policy that required sailors to apply for reenlistment. It was particularly heavily used after the recession. Many sailors were deemed ineligible to reenlist based on their applications.

Our conversations with subject matter experts in the Navy revealed two effects of PTS that are detrimental to our analysis:

- The stated criterion for rejecting reenlistment (preventing overmanning in particular communities) was applied inconsistently
- Due to a data problem, some sailors who decided not to reenlist were marked as ineligible to reenlist.

We find empirical evidence to support the former: during the time period in which PTS was most strongly in effect, the ratio of authorized billets to filled billets in a person's paygrade and/or EMC was either not correlated with an individual's reenlistment probability or was positively correlated with it (that is, had "the wrong sign."). Unfortunately, the existence of the first problem above made our efforts to resolve the second one unsuccessful. That is, we could not reliably impute which sailors left of their own accord and which were truly ineligible to reenlist.

This presents a major problem: without knowing which sailors wanted to reenlist but were not able to do so, we cannot deduce what the real reenlistment rate would have been had everyone who wanted to reenlist been able to do so. In this appendix, we present a segmented regression in which we allow the relationship between retention and key explanatory variables (particularly the economic components) to vary during different time periods: (1) before the recession, (2) after the recession but before August 2009 (when PTS was a more minor issue), and (3) after December 2009. Broadly speaking, we find that PTS is highly correlated with unexplainable results, signifying that

the factors that affected retention before PTS were different from those that affected retention during PTS.

To test whether any perceptible changes occurred in our estimated relationships during the recession and the time that PTS was most heavily enforced, we estimate these relationships in each of the periods defined below. We define the beginning of the most recent poor economic time as December 2007 and onward. As a result of conversations with our sponsors, we assume that PTS was most heavily enforced between September 2009 and the end of our sample period (September 2012). We add to the benchmark regression a measure of manning ratios and indicators for each of the periods. The different segments were excluded from our main analysis because the inclusion of fixed period-specific shocks makes the model considerably less useful for predicting the future retention rate.[6]

Table 17 shows how the estimated relationship between the economic variables and the retention rate changed over these periods. Note that the "solely recession" period was relatively short and gives dramatically imprecise estimates; these should not be taken at face value. As the table shows, all of the relationships change dramatically when we allow for period-specific effects.[7]

As with Zone A sailors, for Zone B sailors (as shown in table 18), the unemployment and Treasury rate component in normal economic times is relatively similar to those estimated previously, while the other components now more closely match our a priori expectations. Furthermore, we once again see that during PTS, the relationship between the economic variables and the retention rate changed dramatically, sometimes to something unexplainable.

---

6. In addition, the inclusion of period-specific indicator variables changes the estimates of the components during "normal" economic times. Two things are noteworthy. First, the unemployment and Treasury rate component changes minimally. Second, the sign of the other components is now generally as we would expect, and the marginal effect of the production growth component in particular is larger than in the full, unsegmented sample.

7. The manning ratio in the paygrade (unreported here) also changes dramatically—from essentially zero to strongly correlated with *higher* rates of reenlistment.

Table 17. Did PTS affect Zone A estimates?

Sailors	Time period	Unemployment and Treasury rate component	Production growth component	Price index component
Zone B men	Before Dec. 2007	**-8.7** [-9.0, -8.3]	**-3.1** [-3.4, -2.7]	**0.5** [0.2, 0.7]
	Dec. 2007 through Aug. 2009	**-7.9** [-76.1, 60.4]	**1.4** [-24.2, 27.1]	**-2.0** [-43.9, 40.0]
	After Aug. 2009	**2.3** [1.5, 3.2]	**21.7** [17.2, 26.1]	**-2.5** [-8.4, 3.3]
Zone B women	Before Dec. 2007	**-7.5** [-8.5, -6.5]	**-4.1** [-5.0, -3.1]	**0.6** [0.0, 1.3]
	Dec. 2007 through Aug. 2009	**3.3** [-0.9, 7.4]	**-0.4** [-6.0, 5.3]	**-4.5** [-14.2, 5.2]
	After Aug. 2009	**3.3** [2.3, 4.2]	**17.4** [13.0, 21.8]	**-11.2** [-13.2, -9.1]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.

Table 18. Did PTS affect Zone B estimates?

Sailors	Time period	Unemployment and Treasury rate component	Production growth component	Price index component
Zone B men	Before Dec. 2007	**-4.8** [-5.4, -4.2]	**-2.4** [-3.1, -1.7]	**0.0** [-0.4, 0.5]
	Dec. 2007 through Aug. 2009	**-4.5** [-56.0, 47.0]	**-2.9** [-13.1, 7.4]	**12.6** [6.9, 18.2]
	After Aug. 2009	**5.2** [4.5, 5.9]	**6.2** [-1.1, 13.6]	**-8.4** [-14.8, -2.0]
Zone B women	Before Dec. 2007	**-5.0** [-6.7, -3.3]	**-4.2** [-6.2, -2.1]	**-1.7** [-2.9, -0.5]
	Dec. 2007 through Aug. 2009	**-4.7** [-10.4, 1.1]	**1.9** [-2.7, 6.5]	**0.0** [-6.4, 6.5]
	After Aug. 2009	**6.4** [4.3, 8.5]	**1.8** [-9.2, 12.8]	**0.5** [-12.7, 13.6]

Point estimates are in bold and represent percentage-point changes.
95% confidence intervals are in brackets.

Finally, recall from the main document that PTS also had an effect on the viability of the use of (traditionally valid) "bellwether ratings" to forecast broad changes in retention patterns in the remaining ratings. We interpret the combined evidence to suggest that PTS changed reenlistment behavior in a way that, without knowing which

sailors were denied reenlistment due to PTS, we cannot account for. As a result, we suggest carefully monitoring retention in the PTS-free environment for a return to normal relationships between the economy and retention.

References

[1] M. S. Goldberg. *A Survey of Enlisted Retention: Models and Findings.* CNA Research Memorandum D0004085.A2/Final. Nov. 2001.

[2] B. J. Asch, J. R. Hosek, and J. T. Warner. "New Economics of Manpower in the Post-Cold War Era." In T. Sandler and K. Hartley, eds., *Handbook of Defense Economics. Volume 2: Defense in a Globalized World.* Amsterdam, The Netherlands: Elsevier, 2007 (pp. 1075–1138).

[3] J. T. Warner and B. J. Asch. "The Economics of Military Manpower." In K. Hartley and T. Sandler, eds., *Handbook of Defense Economics, Volume 1.* New York: Elsevier Science, 1995 (pp. 347-398).

[4] L. B. Kahn. "The Long-Term Labor Market Consequences of Graduating From College in a Bad Economy." *Labour Economics* 17, no. 2, 2010: 303–316.

[5] Y. Genda, A. Kondo, and S. Ohta. "Long-Term Effects of a Recession at Labor Market Entry in Japan and the United States." *The Journal of Human Resources* 45, no. 1, Winter 2010: 157–196.

[6] M. L. Hansen and J. W. Wenger. *Why Do Pay Elasticity Estimates Differ?* CNA Research Memorandum D0005644.A2 / Final. Mar. 2002.

[7] J. Peterson, J. Huff, and A. Quester. *The Role of the Delayed Entry Program in Recruiting the All-Volunteer Force.* CNA Research Memorandum DRM-2013-U-005418-Final. Oct. 2013.

This page intentionally left blank

List of figures

This page intentionally left blank

List of tables

CNA
ANALYSIS & SOLUTIONS

3003 Washington Boulevard ● Arlington, VA 22201