# Interpretation and Implications of Previous Sea Pay Estimates

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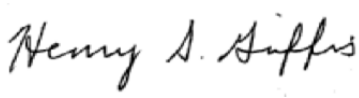

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# Abstract

In this study, we considered three related issues. The first was an update to previous estimates of the amount of sea duty that can be gained from a rise in Career Sea Pay and Career Sea Pay Premium. The second was how to separate multiple effects of sea-duty pay that have been intermingled in previous estimates: the effect of sea pay on reenlistment, the effect on attrition, and the effect on time spent on sea duty, conditional on remaining in the Navy. We also suggest an alternative method for combining sea pay with reenlistment bonuses—a non-linear pricing scheme that would induce personnel to reveal important information about their willingness to reenlist and their willingness to undertake sea duty. Under this pricing mechanism, the Navy could fashion combinations of Selective Reenlistment Bonuses and sea pays that would achieve its reenlistment and sea-duty goals at less cost than the current compensation scheme.

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# Executive Summary

For more than 60 years, the Navy has given sailors extra compensation when on sea duty—both to recognize the hardships that sea duty imposes on sailors and their families, and to induce sailors to spend greater time on sea duty (to resist rolling to shore duty). The Navy's Director, Research, Modeling and Analysis Division (OPNAV N1Z4) asked CNA to assess the effectiveness of the service's Career Sea Pay and Career Sea Pay Premium in inducing sailors to undertake sea duty, and to suggest new approaches to encouraging sailors to undertake voluntary sea duty. In the current analysis, our empirical work on the impact of the current sea-pay schemes has been limited to reexamining previous analyses on sailors' sensitivity to sea pay. These have yielded several useful insights regarding how sea pay bonuses might be better managed. We have also developed a proposal for better coordinating the use of Selective Reenlistment Bonuses (SRBs) and sea pays that, in many circumstances, could make these bonuses significantly more effective.

## The effectiveness of current sea pays

Among our principal findings regarding existing sea pays are the following:

- Over the past 30 years, Career Sea Pay (CSP) has not kept pace with inflation for the majority of those who receive it.
- Analysis from 2002 found that generating an additional person-year of sea duty from a group of typical sailors would require an extra $31,600 in CSP expenditures. Given inflation since that time, and holding all else constant, inducing the same rise in sea duty would now cost $41,412. This amount compares favorably with the other principal, large-scale approach to expanding man years at sea: we estimate that adding time at sea by carrying greater endstrength would cost 2.7 times as much as using Career Sea Pay.[1]

[1] McIntosh and Komis (2010) suggest that small-scale expansions of sea duty may be undertaken at less cost than CSP. They find that, using Sea Duty Incentive Pay (SDIP), the Navy could gain an additional man year of sea duty for only $20,400. SDIP is low cost, however, because it is a highly targeted bonus and can be applied on only a modest scale (it can produce only a modest increase in man years at sea).

- Several factors beyond inflation are likely to have affected sailors' responsiveness to sea pay, including: (1) new constraints on enlisted contract extensions in overmanned ratings (these would likely increase the cost of generating additional sea manning); (2) a shift towards longer sea-duty tours for sailors (previous work indicated that personnel on the longest sea tours were the least responsive to sea-duty pay, but we are uncertain of the implications of this finding to recent changes); (3) lengthening of first enlistment contracts (which, by itself, has the potential to either increase or decrease sailors' sensitivity to sea pay); (4) changes in the relative value of sea pay across paygrades and cumulative sea-duty time (these changes have favored more senior sailors and likely increased the effectiveness of sea-duty pay); and (5) changes in Navy detailing policy that may have increased sailors' sensitivity to sea pay.

  Two of these five effects—lengthening prescribed sea tours and changes in extension policy—could make sailors less sensitive to sea pay and, thereby, raise the cost of generating additional sea-duty time. One—lengthening of first-term enlistment contracts—has an indeterminate effect. The remaining two factors—the change in sea pay across paygrades and the change in Navy detailing policy—would likely make sailors more sensitive to sea pay and act to lower the cost of generating additional sea-duty time.

  Because these five factors cannot be quantified within the constraints of this analysis, and because they act in opposite directions, we will assume that these five factors act to confound each other. As a consequence, our best estimate of the cost of generating additional sea pay is simply the Golding and Gregory (2002) estimate adjusted for inflation: $41,412 per additional person-year of sea duty.

- The Career Sea Pay Premium (CSPP) bonus (which is paid only to sailors with more than 36 months continuous time at sea) is likely to produce more sea-duty time per dollar than Career Sea Pay.[2] Recent changes in sea pay have focused a greater percentage of the increases on CSPP, which has likely increased the effectiveness of sea pays, per dollar of bonus.

- Previous analyses had implicitly viewed sea pay as affecting (1) sailors' attrition, (2) their reenlistment, and (3) the time they spend on sea duty,

[2] CSPP is likely to be more effective than CSP in generating additional sea duty per dollar of bonus because CSPP is more targeted than CSP. CSPP bonuses are offered to sailors only after they have 36 months of continuous time at sea. Sailors who are in the last months of their sea duty are likely to be those who have the greatest desire to roll to shore and are also likely to be those in the best position to voluntarily alter their sea duty. Golding and Gregory (2002) show that sea pays have a particularly strong effect on sailors' extension decisions, and the payment of CSPP is focused late in the sea tour when personnel are often deciding on extension.

conditional on their remaining in the service. We show that sea pays are likely to have little effect on the first two of these factors, but they can have a significant influence on the third. In other words, sea pay should not be thought of as a retention tool, but be focused on increasing sea duty among those who are the most likely to remain in the service.

# A new sea-pay plan

In examining new methods of inducing greater voluntary sea-duty participation, we explored the potential for the Navy coordinating offers of reenlistment bonuses and sea pays. At present, the Navy administers these bonuses sequentially: first sailors are offered SRBs to induce reenlistment and then, for those who accept reenlistment, the service assigns some sailors to sea duty and provides them with CSP (over the term of their sea duty, sailors either continue accepting CSP, or they roll to shore). This sequential approach makes sense when there is little difference among sailors in their taste for sea duty (and their taste for all other aspects of Navy service). However, when there is significant variation among sailors in their willingness to serve on sea duty and in their opinion about Navy service in general, coordinating SRB and sea pay can substantially reduce the costs the Navy bears in inducing reenlistment and maintaining personnel on sea duty.

In developing this approach to coordinating SRBs and sea pay, we make use of "non-linear pricing," a well-known pricing mechanism from the Economics literature that is widely applied to cell phone services, health insurance, and a wide variety of other products. Although some of the technical aspects of implementing such a plan can be complex, to the sailors who would be offered the plan, it would appear to be quite straightforward: it would offer a choice of two reenlistment bonus and sea pay combinations, one weighted towards compensating sea duty and the other weighted more towards service with less sea duty. Among the benefits of this pricing plan is that it would permit the Navy to identify those sailors who are most disposed to serving on sea duty, and to detail to sea duty those with the greatest taste for this type of service. As a result, the Navy would be able to induce sea duty at a lower cost than at present.

In choosing between these two plans, sailors would reveal their relative preferences for sea duty and shore duty. This sort of self-selection, in turn, would permit the Navy to more finely tailor the reenlistment bonuses and sea pays that it offers its personnel, lower the "economic rents" that it pays when manning its billets, and reduce the service's personnel costs (alternatively, it could make the existing personnel budget more effective). The plan has the additional benefit of employing personnel where they most wish to be: those with the strongest preference for shore duty would be more often employed ashore, and those most inclined towards sea duty would be paid to undertake that duty. Finally, the plan, over time, would give

the service greater ability to shape its various communities to its needs: raising the proportion of sailors who are disposed to sea duty in those communities that are sea intensive, and increasing the proportion of sailors inclined to shore duty in those communities that are shore intensive.

Although it has not been possible, within the scope of current analysis, to estimate the savings that might accrue from coordinating SRBs and sea pays, even modest percentage savings in these programs could produce large dollar value savings. In FY 2014, the budget for SRBs (both new commitments and anniversary payments made for previous commitments) and the budget for sea pays (CSP and CSPP) exceeded, in total, a half billion dollars. Even a modest percentage savings in these programs could potentially save tens of millions of dollars.

# Policy recommendations

Our work gives rise to the following policy recommendations:

- To induce sailors to spend greater time at sea, the Navy should target sea pays at those who are most sensitive to these bonuses. This means directing these pays to sailors who are least likely to be facing reenlistment or attrition: these pays should be increasingly targeted at more senior sailors with greater time at sea.

- To produce greater sea time per dollar of sea pay, the service should, where practical, make greater use of closely targeted pays such as Career Sea Pay Premium,[3]and Sea Duty Incentive Pay.[4]

- The Navy should gradually implement a non-linear pricing scheme for more senior personnel (e.g., those enlisting into a second sea tour) in a small number of communities that have significant requirements for both sea and shore duty. The service should then assess the effectiveness of these pilot programs and consider implementing this type of non-linear pricing more widely across the Navy.

[3] The CSPP compensates sailors only when they reach some threshold of continuous sea duty; the current threshold is 36 months.

[4] SDIP is paid to sailors to voluntarily fill specific gapped billets at sea by remaining on sea duty past their prescribed sea tour (PST) or curtailing their shore duty to return to sea.

# Contents

# List of Figures

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# List of Tables

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# Glossary

| | |
|---|---|
| CSP | Career Sea Pay |
| CSPP | Career Sea Pay Premium |
| EAOS | End Of Active Service |
| NPC | Navy Personnel Command |
| PST | Prescribed Sea Tour |
| SRB | Selective Reenlistment Bonus |

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# Background and structure

## Motivation for study

Since before 1950, the Navy has provided extra pay to sailors when they are on sea duty. The service has done this for two principal purposes: to recognize the hardships borne by sailors and their families when personnel are on sea duty, and to encourage sailors to complete the full term of their sea tour and/or to extend at sea beyond the end of their sea tour.[5] There are currently two varieties of sea pay: Career Sea Pay (CSP), which provides a payment to the majority of those on sea duty (this amount varies by sailors' paygrade and *cumulative* time on sea duty);[6] and Career Sea Pay Premium (CSPP),[7] which provides a payment to a select group of sailors (defined by paygrade and cumulative time on sea duty) who have more than 36 months of *continuous* sea duty during their current sea-duty assignment.[8]

Unlike the majority of military pay, the values of CSP and CSPP have been adjusted only occasionally. There have been long periods when the nominal (current dollar) value of these bonuses has remained fixed and, as a result, inflation has eaten away at the purchasing power (the real value) of these pays. For example, there was no adjustment to the CSP between 1988 and 2000, nor in the period 2002 to 2013. The Navy recently implemented a significant rise in the value of sea pays for many classes of sailors, and our sponsor—Director, Research, Modeling and Analysis Division (OPNAV N1Z4)—is interested in assessing how this increase, and possible

[5] There are many reasons why personnel fail to complete their sea duty, some of which are under the sailors' control and others are not. This issue is explored in detail in (M. F. McIntosh, D. Gregory, 2013) and is discussed further later in this study.

[6] As Golding and Gregory (2002) indicate, most, but not all, sailors on sea duty for rotational purposes receive sea pay. See U.S. Code, Title 37, Section 305a for details.

[7] In this study, we use the terms "sea pay" and "Career Sea Pay" interchangeably. Career Sea Pay is always treated as being distinct from Career Sea Pay Premium.

[8] Sailors may receive a variety of other pays while they are on sea duty, such as hazardous duty pays, career incentive pays, and retention pays, but these are paid to sailors on either sea or shore duty and are not specifically tailored to increasing the time sailors spend on their sea tours.

future increases, might affect the time that sailors are willing to spend at sea. The sponsor has asked CNA to consider the existing literature on the effects of sea duty and, if possible, to extrapolate from these works the likely behavioral responses to increases in sea pays. The sponsor also asked that we consider improvements to how the Navy uses its sea-pay monies and to identify ways to make these bonuses more effective in increasing the time that sailors spend at sea.

## The structure of the study

In the first part of this analysis, we examine the history of the Navy's sea pays and consider how the service has targeted these pays, how it has adjusted the value of these pays over time, and how the use of these pays has been coordinated with other policies. A key finding is that the Navy has been maintaining the long-term purchasing power of these pays for more senior sailors who have amassed greater time at sea, but the service has been allowing the real value of these pays to erode for more junior sailors. We argue later in this study that it is precisely the more senior sailors to whom sea pay should be targeted because it is these personnel on whom these bonuses have the greatest effect.

In the second section of this study, we examine what is perhaps the best known work on sea pay, Golding & Gregory (2002). These authors examined the effects of sea-pay on sea-tour completion among sailors who served between 1982 and 1998. This analysis found that sea pay has a small but statistically significant effect on the completion of sea tours: "in general, a $50 increase in total monthly sea pay [in 2002 dollars] boosts… completions of 48 month sea tours by 3.3 percentage points, or 11 percent." The authors also estimated that the Navy would gain annually about 1,425 work-years of sea duty at a cost of $45 million if sailors received an additional $50 per month in sea pay." This translates into about $31,600 per extra work-year of sea duty generated.

In the current study, we revisit Golding & Gregory (2002) and extrapolate from their results to form an estimate of how sea pays would likely affect sea-tour completions. One aspect of this effort is adjusting for inflation. Because the purchasing power of the dollar has declined over the 12 years since the original analysis was published, we modify the previous estimates to account for the 32-percent rise in prices since 2002. In effect, the Navy would have to pay $66 in current (2014) dollars to achieve the same increase in sea-tour completions as would have resulted from a $50 rise in sea pay in 2002.

The third part of the current analysis reconsiders the intended effects of sea pay and reexamines the mechanisms through which sea pays affect sailors' behavior. The earlier analysis considered the effect of sea pay on sailors' time at sea, including *both* the effect of the bonuses on sailors' retention decisions and the effect on time served

at sea, conditional on retention. We suggest that sea pays should be employed with a relatively narrow intent—to raise sea-duty completion and sea duty extensions among those sailors who have already made the decision to remain in the Navy. We argue that, to the extent possible, sea pay should *not* be used as an incentive for retention because, when used as it has been applied traditionally, it is largely ineffective in this role. (However, later in this study, we argue that better coordinating the use of sea pays and reenlistment bonuses can be highly effective in *simultaneously* raising sea-duty time *and* inducing greater retention).

We suggest paying *less* sea pay to those who are within their first enlistment and who are on their first sea tour (this corresponds to the way the service has been adjusting the real value of sea-pay bonuses over recent decades). A key finding of this analysis is that when sea pays are used in this way (when they are paid to sailors who have a high likelihood of remaining in the service), they are much more effective than previously estimated in raising the amount of time that sailors spend at sea.

In the fourth part of this analysis, we explore the potential for the Navy coordinating offers of reenlistment bonuses and sea pays under a "non-linear pricing plan." We show that, in circumstances where it could be appropriately employed, the plan would permit the Navy to more finely tailor the reenlistment bonuses and sea pays that it offers its personnel, lowering the "economic rents" that it pays when manning its billets, and reducing the service's personnel costs (or making the existing personnel budget more effective). This plan, over time, would give the service greater ability to shape its various communities, raising the proportion of sailors who are disposed to sea duty in those communities that are sea intensive, and increasing the proportion of sailors inclined to shore duty in those communities that are shore intensive.

# The history of sea pay

## Career Sea Pay

### The 1981 to 1988 era

Prior to October 1981, the Navy offered only modest sea pay. There was no differentiation by paygrade in the amounts sailors received; pay varied by sailors' cumulative sea duty: those with 4 years of cumulative sea duty were paid $29 per month, while those with more than 12 years received $115. Beginning in FY 1982, however, the Navy implemented a sharp rise in sea pay and began to differentiate these bonuses by paygrade. For example, in that year, as shown in Table 1, an E-4 with only 2 years of sea time was paid $125 per month, and those with higher paygrades and longer cumulative time at sea could be paid significantly more (up to $310).

Table 1. CSP amounts, beginning FY 1982

| | Cumulative Years of Sea Duty | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Paygrade | 1 Year or Less | Over 1 | Over 2 | Over 3 | Over 4 | Over 5 | Over 6 | Over 7 | Over 8 | Over 9 | Over 10 | Over 11 | Over 12 |
| O-6 | 0 | 0 | 0 | 225 | 230 | 230 | 240 | 255 | 265 | 280 | 290 | 300 | 310 |
| O-5 | 0 | 0 | 0 | 225 | 225 | 225 | 225 | 230 | 245 | 250 | 260 | 265 | 265 |
| O-4 | 0 | 0 | 0 | 185 | 190 | 200 | 205 | 215 | 215 | 220 | 225 | 225 | 240 |
| O-3 | 0 | 0 | 0 | 150 | 160 | 185 | 190 | 195 | 205 | 215 | 225 | 225 | 240 |
| O-2 | 0 | 0 | 0 | 150 | 160 | 185 | 190 | 195 | 205 | 215 | 225 | 225 | 240 |
| O-1 | 0 | 0 | 0 | 150 | 160 | 185 | 190 | 195 | 205 | 215 | 225 | 225 | 240 |
| W-4 | 150 | 150 | 150 | 150 | 170 | 290 | 310 | 310 | 310 | 310 | 310 | 310 | 310 |
| W-3 | 150 | 150 | 150 | 150 | 170 | 270 | 280 | 285 | 290 | 300 | 310 | 310 | 310 |
| W-2 | 150 | 150 | 150 | 150 | 170 | 260 | 265 | 265 | 270 | 275 | 280 | 290 | 310 |
| W-1 | 130 | 135 | 140 | 150 | 170 | 175 | 200 | 250 | 270 | 275 | 280 | 290 | 300 |
| E-9 | 175 | 195 | 235 | 265 | 280 | 290 | 310 | 310 | 310 | 310 | 310 | 310 | 310 |
| E-8 | 165 | 180 | 225 | 255 | 265 | 270 | 280 | 285 | 290 | 300 | 310 | 310 | 310 |
| E-7 | 135 | 145 | 215 | 235 | 255 | 260 | 265 | 265 | 270 | 275 | 280 | 300 | 310 |
| E-6 | 125 | 135 | 170 | 190 | 210 | 215 | 225 | 235 | 245 | 255 | 255 | 255 | 255 |
| E-5 | 60 | 70 | 140 | 175 | 185 | 190 | 205 | 220 | 220 | 220 | 220 | 220 | 220 |
| E-4 | 50 | 60 | 125 | 160 | 175 | 175 | 175 | 175 | 175 | 175 | 175 | 175 | 175 |

Source: Data on sea pay from https://www.navycs.com/charts/ (accessed Oct. 1, 2014).

The nominal value of sea pay shown in Table 1 stayed unchanged through FY 1988, and, as a result, the purchasing power of the bonus was eroded by inflation. By 1988, the real value of the bonus for an E-6 with 8 years of cumulative sea duty had fallen by 13 percent (from $245 to $214, measured in 1982 dollars).

## The 1988 to 2001 era

On May 1, 1988, the Navy implemented a large rise in sea pay for many classifications of sailors. The percent increases in nominal CSP, which are shown in Table 2, were skewed in favor of sailors with higher paygrades and longer cumulative time at sea. With this increase, the real value of sea pay for many sailors reached its historical maximum (e.g., E-6 sailors with 8 years of cumulative sea duty earned $294 in 1982 dollars). On the other hand, some more junior personnel and some with little cumulative time at sea experienced *reductions* in their nominal sea pay: E-4s with 2 years of cumulative sea time saw their sea duty pay fall from $125 per month to $120 per month.

Table 2. Percent change in nominal CSP in 1988 (by paygrade and sea time)

| | Cumulative Years of Sea Duty | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Less than | Over | Over | Over | Over | Over | Over | Over | Over | Over | Over | Over | Over |
| Paygrade | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| O-6 | ~ | ~ | ~ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O-5 | ~ | ~ | ~ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O-4 | ~ | ~ | ~ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O-3 | ~ | ~ | ~ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O-2 | ~ | ~ | ~ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O-1 | ~ | ~ | ~ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| W-5 | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ |
| W-4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 6 | 13 |
| W-3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| W-2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| W-1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E-9 | -43 | -49 | -49 | -34 | -32 | 21 | 13 | 21 | 26 | 29 | 29 | 32 | 35 |
| E-8 | -39 | -44 | -47 | -31 | -28 | 30 | 25 | 32 | 34 | 33 | 29 | 32 | 35 |
| E-7 | -26 | -31 | -44 | -26 | -25 | 35 | 32 | 42 | 44 | 45 | 43 | 37 | 35 |
| E-6 | -20 | -26 | -29 | -21 | -19 | 47 | 44 | 49 | 43 | 43 | 43 | 43 | 49 |
| E-5 | -17 | -14 | -14 | -14 | -8 | 66 | 59 | 59 | 59 | 59 | 59 | 59 | 59 |
| E-4 | 0 | 0 | -4 | -6 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 | -9 |

A decrease

An increase of 20-29 percent

An increase of 30-39 percent

An increase of 40 percent or more (* indicates zero CSP in initial year)

Source: Data on sea pay from https://www.navycs.com/charts/ (accessed Oct. 1, 2014).

[a.] In 1988, the Navy began to differentiate sea-pay bonuses by cumulative time at sea from 13 years to 20 years.

## The 2001 to 2013 era

Yet another increase in sea pay was implemented on October 1, 2001. Once again, some classes of sailors benefited more than others, but, in this instance, the patterns of change are not easy to characterize. All E-4s with more than 3 years of cumulative sea duty saw increases in sea pay of at least 81 percent (those with more than 8 years saw increases of 144 percent). In contrast, those just one paygrade higher (E-5s) who had 5 to 7 years of sea duty experienced *no* increase in nominal sea pay. Table 3 shows the percentage change in nominal sea pay that occurred in 2001 (by paygrade and cumulative sea time). The small (zero) increase in sea pay for enlisted personnel

in the E-5 through E-9 paygrade with 5 through 7 years of cumulative sea duty reflected the fact that these personnel were, in 2001, made eligible for Career Sea Pay Premium (CSPP) and were able to receive up to $100 for every continuous month at sea over 36 months. The CSPP is discussed in greater detail later in this paper.

Table 3. Percent change in nominal CSP in 2001 (by paygrade and sea time)

| | Cumulative Years of Sea Duty | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Paygrade | Less than 1 | Over 1 | Over 2 | Over 3 | Over 4 | Over 5 | Over 6 | Over 7 | Over 8 | Over 9 | Over 10 | Over 11 | Over 12 | Over 13 | Over 14 | Over 16 | Over 18 | Over 20 |
| O-6 | * | * | * | 40 | 39 | 39 | 40 | 41 | 40 | 41 | 40 | 40 | 40 | 40 | 40 | 40 | 41 | 41 |
| O-5 | * | * | * | 40 | 40 | 40 | 40 | 39 | 41 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| O-4 | * | * | * | 41 | 39 | 40 | 39 | 40 | 44 | 41 | 40 | 40 | 40 | 40 | 41 | 41 | 40 | 40 |
| O-3 | * | * | * | 40 | 41 | 41 | 39 | 41 | 39 | 40 | 40 | 40 | 40 | 40 | 40 | 41 | 41 | 40 |
| O-2 | * | * | * | 40 | 41 | 41 | 39 | 41 | 39 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41 | 41 |
| O-1 | * | * | * | 40 | 41 | 41 | 39 | 41 | 39 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41 | 41 |
| W-5 | | | | | | | | | | | | | | | | | | |
| W-4 | 40 | 40 | 40 | 40 | 41 | 40 | 40 | 40 | 40 | 40 | 53 | 59 | 60 | 60 | 70 | 62 | 71 | |
| W-3 | 40 | 40 | 40 | 40 | 41 | 41 | 41 | 40 | 40 | 45 | 58 | 69 | 70 | 70 | 70 | 61 | 62 | |
| W-2 | 40 | 40 | 40 | 40 | 41 | 40 | 40 | 40 | 41 | 58 | 70 | 64 | 69 | 69 | 70 | 60 | 51 | |
| W-1 | 38 | 41 | 39 | 40 | 41 | 40 | 40 | 40 | 41 | 53 | 63 | 57 | 58 | 58 | 68 | 75 | 75 | |
| E-9 | 35 | 35 | 33 | 74 | 68 | 0 | 0 | 0 | 26 | 25 | 25 | 24 | 24 | 22 | 21 | 19 | 19 | |
| E-8 | 35 | 35 | 33 | 74 | 68 | 0 | 0 | 0 | 26 | 25 | 25 | 24 | 24 | 22 | 21 | 20 | 19 | |
| E-7 | 35 | 35 | 33 | 74 | 68 | 0 | 0 | 0 | 26 | 25 | 25 | 24 | 24 | 22 | 21 | 20 | 20 | |
| E-6 | 35 | 35 | 33 | 87 | 76 | 0 | 0 | 0 | 29 | 27 | 27 | 27 | 26 | 25 | 24 | 24 | 22 | |
| E-5 | 40 | 33 | 33 | 87 | 76 | 0 | 0 | 0 | 29 | 29 | 29 | 29 | 29 | 29 | 29 | * | * | |
| E-4 | 40 | 33 | 33 | 87 | 81 | 81 | 81 | 81 | 144 | 144 | 144 | 144 | 144 | 144 | 144 | * | * | |
| E-3 | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | |
| E-2 | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | |
| E-1 | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | |
| | An increase of 20-29 percent | | | | | | | | | | | | | | | | | |
| | An increase of 30-39 percent | | | | | | | | | | | | | | | | | |
| | An increase of 40 percent or more (* indicates zero CSP in initial year) | | | | | | | | | | | | | | | | | |

Source: Data on sea pay from https://www.navycs.com/charts/ (accessed Oct. 1, 2014).

## The current era

The most recent rise in sea pay was implemented on May 1, 2014. This increase was far more uniformly distributed across personnel than those of 1998 or 2001. The great majority of sailors with 3 years or more of cumulative sea time received a 25-percent rise in sea pay (see Table 4). However, many enlisted personnel with more than 8 years of cumulative sea pay received still higher increases—some as high as 42 percent. The large increases in sea pay for those in the E-5 through E-9 paygrades with sea duty over 8 years reflect the fact that the CSPP is not paid to these personnel (the larger sea pay was intended to offset the lack of CSPP).[9]

[9] DoD 7000.14-R *Financial Management Regulation* Volume 7A, Chapter 18, July 2014

Table 4. Percent increase in nominal CSP from 2013 to 2014 (by paygrade and sea time)

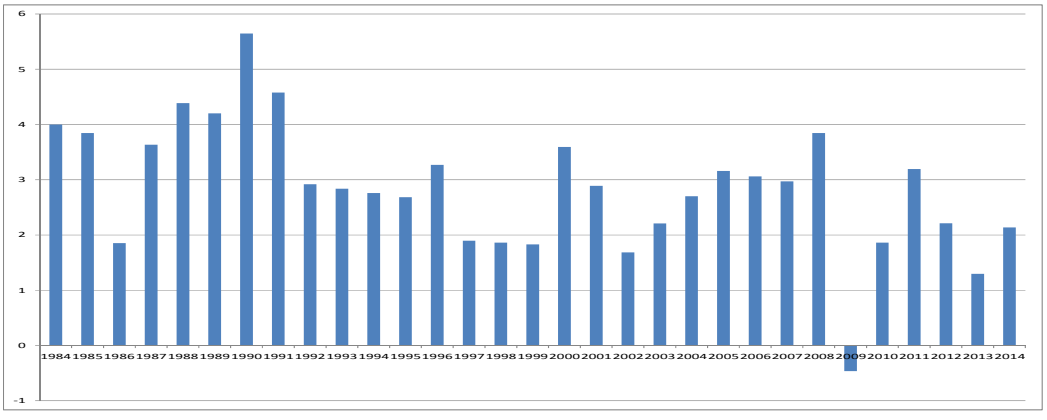
| | Cumulative Years of Sea Duty | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Less than | Over | Over | Over | Over | Over | Over | Over | Over | Over | Over | Over | Over | Over | Over | Over | Over | Over |
| Paygrade | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 16 | 18 | 20 |
| O-6 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| O-5 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| O-4 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| O-3 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| O-2 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| O-1 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| W-5 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 19 | 19 | 7 | 7 |
| W-4 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 19 | 19 | 7 | 7 |
| W-3 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 19 | 19 |
| W-2 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| W-1 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| E-9 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 40 | 40 | 40 | 40 | 39 | 36 | 30 | 21 | 21 | 21 |
| E-8 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 40 | 40 | 40 | 40 | 39 | 36 | 30 | 25 | 21 | 21 |
| E-7 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 40 | 40 | 40 | 40 | 39 | 36 | 30 | 25 | 25 | 25 |
| E-6 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 42 | 41 | 41 | 41 | 41 | 40 | 40 | 39 | 36 | 36 |
| E-5 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 |
| E-4 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| E-3 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| E-2 | 0 | 0 | 0 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| E-1 | 0 | 0 | 0 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 |
| | | | An increase of 20-29 percent | | | | | | | | | | | | | | | |
| | | | An increase of 30-39 percent | | | | | | | | | | | | | | | |
| | | | An increase of 40-41 percent | | | | | | | | | | | | | | | |

Source: Data on sea pay from https://www.navycs.com/charts/ (accessed Oct. 1, 2014).

# The purchasing power of CSP over time

In addition to the changes in nominal sea pay implemented by the Navy, the purchasing power of these bonuses has also been affected by inflation. From 1984 to 2014, consumer prices increased, on average, almost 3 percent per year. Figure 1 shows the pattern of inflation over this period. Table 5 shows how the real purchasing power of sea pay has changed over that period.

Figure 1. Inflation from 1984 to 2014




Source: Inflation data from http://data.bls.gov/cgi-bin/cpicalc.pl?cost1=1.00&year1=1983&year2=2014;

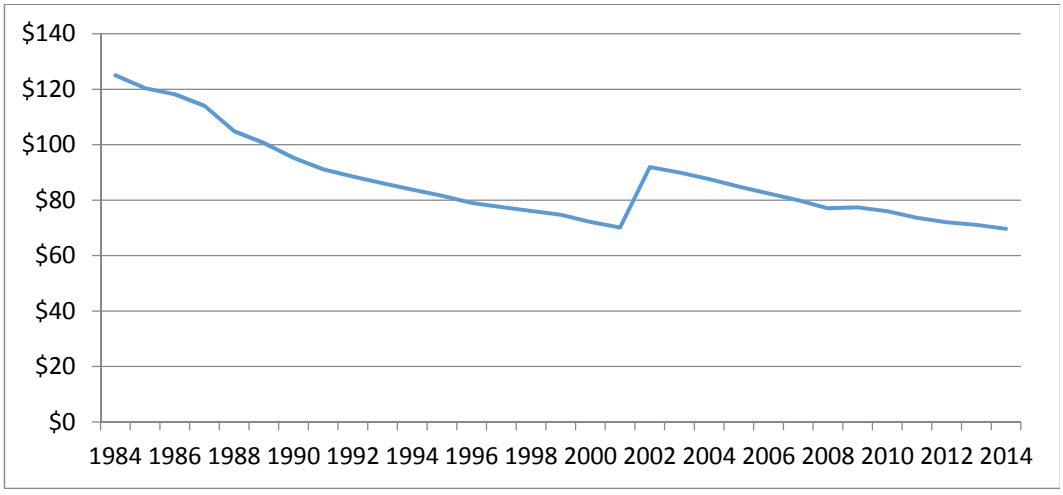
Table 5. Purchasing power of CSP in 2014 compared to 1982

| | Cumulative Years of Sea Duty | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 or less | Over 1 | Over 2 | Over 3 | Over 4 | Over 5 | Over 6 | Over 7 | Over 8 | Over 9 | Over 10 | Over 11 | Over 12 |
| O-6 | | | | 77.83 | 77.29 | 77.29 | 77.59 | 78.43 | 77.65 | 78.41 | 77.55 | 77.78 | 77.99 |
| O-5 | | | | 77.83 | 77.83 | 77.83 | 77.29 | 78.19 | 77.87 | 77.95 | 77.65 | 77.65 | |
| O-4 | | | | 78.08 | 77.43 | 77.78 | 77.18 | 77.52 | 80.21 | 78.38 | 77.83 | 77.83 | 77.59 |
| O-3 | | | | 77.93 | 78.06 | 78.08 | 77.43 | 78.40 | 77.18 | 77.52 | 77.83 | 77.83 | 77.59 |
| O-2 | | | | 77.93 | 78.06 | 78.08 | 77.43 | 78.40 | 77.18 | 77.52 | 77.83 | 77.83 | 77.59 |
| O-1 | | | | 77.93 | 78.06 | 78.08 | 77.43 | 78.40 | 77.18 | 77.52 | 77.83 | 77.83 | 77.59 |
| W-5 | | | | | | | | | | | | | |
| W-4 | 62.22 | 62.22 | 62.22 | 77.93 | 78.43 | 77.55 | 77.99 | 77.99 | 77.99 | 77.99 | 87.89 | 94.05 | 100.36 |
| W-3 | 62.22 | 62.22 | 62.22 | 77.93 | 78.43 | 78.19 | 78.41 | 77.97 | 77.55 | 80.59 | 87.89 | 94.05 | 100.36 |
| W-2 | 62.22 | 62.22 | 62.22 | 77.93 | 78.43 | 77.95 | 77.65 | 77.65 | 78.19 | 87.92 | 94.29 | 91.03 | 94.05 |
| W-1 | 61.54 | 62.55 | 61.90 | 77.93 | 78.43 | 77.71 | 77.78 | 77.87 | 78.19 | 84.85 | 90.32 | 87.20 | 88.00 |
| E-9 | 34.29 | 30.77 | 30.26 | 63.90 | 63.49 | 67.13 | 62.80 | 67.24 | 98.64 | 100.36 | 100.36 | 102.22 | 103.94 |
| E-8 | 36.36 | 33.33 | 31.60 | 66.41 | 67.09 | 72.10 | 69.52 | 73.14 | 105.44 | 103.70 | 100.36 | 102.22 | 103.94 |
| E-7 | 44.44 | 41.38 | 33.07 | 72.06 | 69.72 | 74.87 | 73.46 | 78.66 | 113.25 | 113.13 | 111.11 | 105.63 | 103.94 |
| E-6 | 48.00 | 44.44 | 41.83 | 81.87 | 79.37 | 81.45 | 80.20 | 82.84 | 115.74 | 114.34 | 114.34 | 114.34 | 117.65 |
| E-5 | 51.85 | 50.79 | 50.79 | 88.89 | 90.09 | 92.16 | 88.02 | 88.48 | 128.89 | 128.89 | 128.89 | 128.89 | 128.89 |
| E-4 | 62.22 | 59.26 | 56.89 | 97.22 | 92.19 | 92.19 | 92.19 | 92.19 | 123.94 | 123.94 | 123.94 | 123.94 | 123.94 |
| | | | | | | | | | | | | | |
| | | | Purchasing power declined to 50-74 percent of 1982 level | | | | | | | | | | |
| | | | Purchasing power declined to 75-99 percent of 1982 level | | | | | | | | | | |
| | | | Purchasing power increased (it is more than 100 percent of 1982 level) | | | | | | | | | | |

Source: Data on sea pay from https://www.navycs.com/charts/ (accessed October 1, 2014).

For most sailors, the periodic increases in the nominal sea pay have failed to keep pace with inflation and, for these personnel, the real value of sea pay has declined over the past 30 years. One can see in Figure 2 a particularly sharp decline in the real value of sea pay for sailors in the E-4 paygrade who have only 2 years of accumulated sea time: the purchasing power of sea pay for these personnel is now only 56 percent of what it was in 1982 (see Figure 4).

Figure 2. Real purchasing power of CSP for an E-4 with 2 years cumulative sea duty (in 1984 dollars).

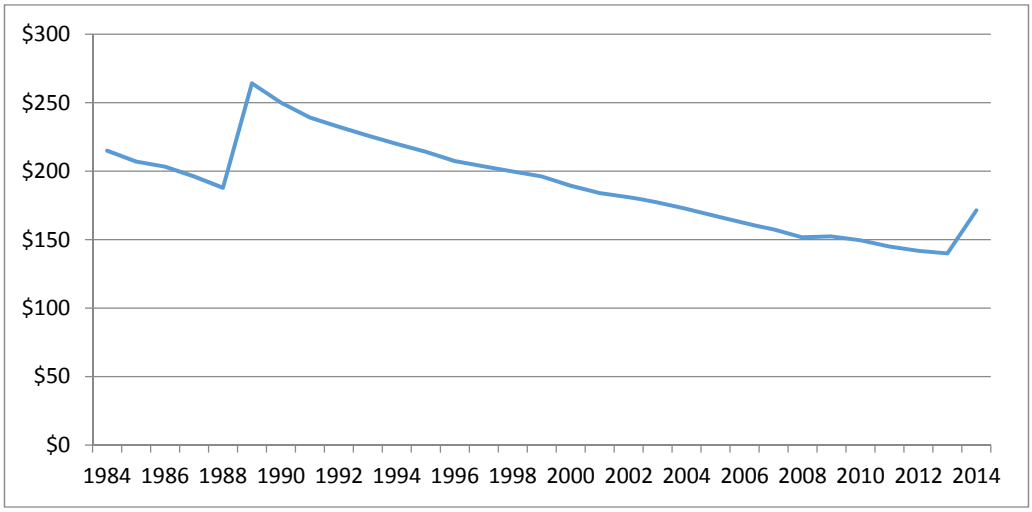



70/125Source: Inflation data from http://data.bls.gov/cgi-bin/cpicalc.pl?cost1=1.00&year1=1983&year2=2014; data on sea pay from https://www.navycs.com/charts/ (accessed October 1, 2014).

We argue later in this analysis that cutting sea pay for these most junior personnel may be desirable because providing sea pay to these sailors may be wasteful; a large proportion of these personnel will decide to leave the Navy well before the end of their Prescribed Sea Tour (PST), and, we suggest, these decisions to depart the Navy are largely insensitive to sea pay.

Figure 3 shows purchasing power of sea pay for more senior sailors, E-6s with 5 years of cumulative sea data. These personnel enjoyed a significant uptick in the real value of their sea pay in 1988 (when the purchasing power of their CSP reached a maximum), but they experienced a long decline in the real value of sea pay from 1988 to 2013. The most recent rise in nominal sea pay (implemented in May 2014) only partially offsets this trend. At present, the real sea pay for these personnel (in 1982 dollars) stands 20 percent below the level that pertained in 1982 and 35 percent below the level of 1988.

Figure 3. Real purchasing power of CSP for an E-6 with 5 years cumulative sea duty (in 1984 dollars).

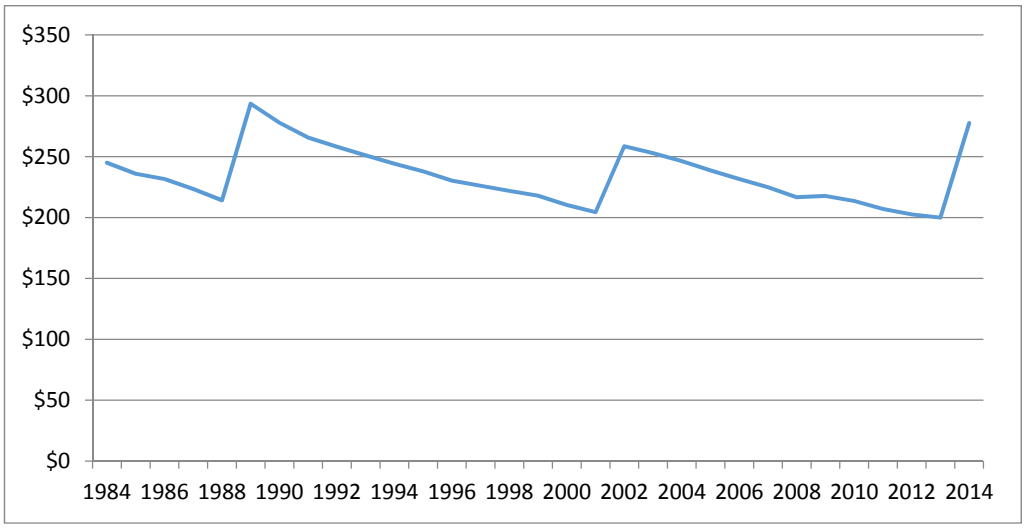



Source: Inflation data from http://data.bls.gov/cgi-bin/cpicalc.pl?cost1=1.00&year1=1983&year2=2014; data on sea pay from https://www.navycs.com/charts/ (accessed October 1, 2014).

Many of these E-6s with 5 years of cumulative sea duty will be on their second sea tour in a third enlistment, and a relatively small proportion will fail to complete their PST because of attrition or failure to reenlist. As a result, providing sea pay to these personnel would be associated with less economic rent than providing these bonuses to more junior sailors.

The highest levels of sea pay, and the greatest stability in the real purchasing power of sea pay, have been experienced by sailors with the greatest number of years at sea. For example, as illustrated in Figure 4, E-6s with more than 8 years of cumulative sea duty have seen the purchasing power of their sea pay remain relatively stable at around $250 per month (in 1982 dollars) over the past 30 years.

Figure 4. Real purchasing power of CSP for E-6s with 8 years cumulative sea duty (in 1984 dollars).




Source: Inflation data from http://data.bls.gov/cgi-bin/cpicalc.pl?cost1=1.00&year1=1983&year2=2014; data on sea pay from https://www.navycs.com/charts/ (accessed October 1, 2014).

# The Career Sea Pay Premium

Since 1980, the Navy has provided an additional financial incentive for sea duty, the Career Sea Pay Premium (CSPP). This bonus is paid to sailors who are eligible to receive the CSP and who have at least 36 months of *consecutive* sea duty.

As shown in figures 5 through 8, over the period 1980 to 2013, the Navy maintained the CSPP at the level of $100 per month. Inflation over these 33 years resulted in the real purchasing power of this bonus declining by 65 percent. In 2014, the Navy doubled the nominal value of this bonus (raising it from $100 to $200), but, even with this adjustment, the purchasing power of the CSPP is still less than 70 percent of the level of 1980.

The Navy has periodically changed the classifications of sailors to whom it offers the CSPP bonus. The most recent adjustment of this type was made in 2001 when the service reinstated the CSPP to those personnel who were in the paygrades E-5 and above who have 5 years to 7 years of cumulative sea duty.

Figure 5. CSPP amounts in initial 1980 legislation

| | Cumulative Years of Sea Duty | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Paygrade | 1 Year or Less | Over 1 | Over 2 | Over 3 | Over 4 | Over 5 | Over 6 | Over 7 | Over 8 | Over 9 | Over 10 | Over 11 | Over 12 |
| E-9 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| E-8 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| E-7 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| E-6 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| E-5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| E-4 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Source: Public Law 96-579, Sec 4(a), 94 Stat. 3359, 3364-3366 (1980)

Figure 6. CSPP amounts revised in 1987

| | Cumulative Years of Sea Duty | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Paygrade | 1 Year or Less | Over 1 | Over 2 | Over 3 | Over 4 | Over 5 | Over 6 | Over 7 | Over 8 | Over 9 | Over 10 | Over 11 | Over 12 |
| E-9 | 100 | 100 | 100 | 100 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E-8 | 100 | 100 | 100 | 100 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E-7 | 100 | 100 | 100 | 100 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E-6 | 100 | 100 | 100 | 100 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E-5 | 100 | 100 | 100 | 100 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E-4 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Source: Public Law 100-180, 101 Stat. 1019, 1097-1100 (1987)

Figure 7. CSPP amounts revised in 2001

| | Cumulative Years of Sea Duty | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Paygrade | 1 Year or Less | Over 1 | Over 2 | Over 3 | Over 4 | Over 5 | Over 6 | Over 7 | Over 8 | Over 9 | Over 10 | Over 11 | Over 12 |
| E-9 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 0 | 0 | 0 | 0 |
| E-8 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 0 | 0 | 0 | 0 |
| E-7 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 0 | 0 | 0 | 0 |
| E-6 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 0 | 0 | 0 | 0 |
| E-5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 0 | 0 | 0 | 0 |
| E-4 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | ~ | ~ | ~ | ~ | ~ |
| E-3 | 100 | 100 | 100 | 100 | 100 | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ |
| E-2 | 100 | 100 | 100 | 100 | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ |
| E-1 | 100 | 100 | 100 | 100 | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ |

Figure 8. CSPP amounts revised 2014

| | Cumulative Years of Sea Duty | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Paygrade | 1 Year or Less | Over 1 | Over 2 | Over 3 | Over 4 | Over 5 | Over 6 | Over 7 | Over 8 | Over 9 | Over 10 | Over 11 | Over 12 |
| E-9 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 0 | 0 | 0 | 0 | 0 |
| E-8 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 0 | 0 | 0 | 0 | 0 |
| E-7 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 0 | 0 | 0 | 0 | 0 |
| E-6 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 0 | 0 | 0 | 0 | 0 |
| E-5 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 0 | 0 | 0 | 0 | 0 |
| E-4 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | ~ | ~ | ~ | ~ | ~ |
| E-3 | 200 | 200 | 200 | 200 | 200 | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ |
| E-2 | 200 | 200 | 200 | 200 | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ |
| E-1 | 200 | 200 | 200 | 200 | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ | ~ |

We have previously observed that there are two motivations for offering sea pay: to recognize the more arduous conditions under which sailors work when they are on sea duty, and to induce sailors to complete their sea tours. If one were to focus only on the second of these motives, it seems likely that CSPP would be more effective than CSP in generating additional sea duty per dollar of bonus. The reason for this is that CSPP is more targeted than CSP. These pays are offered to sailors only after they have 36 months of continuous time at sea. Sailors who are in the last months of their sea duty are likely to be those who have the greatest desire to roll to shore and are also likely to be those in the best position to voluntarily alter their sea duty (for example, Golding and Gregory (2002) show that sea pays have a particularly strong effect on sailors' extension decisions, and the payment of CSPP is focused late in the sea tour when personnel are often deciding on extension). Because we expect that a dollar spent on CSPP will yield greater sea-duty time than a dollar of CSP, we encourage the service to make greater use of these pays.

# Applying earlier findings

In their analysis, Golding and Gregory (2002) examined the relationship between sea duty served by Navy personnel and the amount of sea pay they receive. Their study covered the period October 1, 1983, through October 30, 1999, and distinguished between those serving different tour lengths (36 months, 48 months, and 60 months). Their analysis, however, did not distinguish among sailors by whether they were on their first sea tour or a later sea tour.

The authors found substantial differences in the sensitivity to sea pay across sea-tour lengths. Those on 48-month sea tours (and these were 70 percent of those who had been in the Golding and Gregory (2002) study) were found to be the most sensitive to sea pay. Those on 36-month sea tours (3 percent of the sample) were found to be as sensitive as those on 48-month tours during the first 12 months of sea duty, but were only 40 percent as sensitive in the second year, and only 25 percent as sensitive in their third year.[10] Least sensitive of all were those on 60-month sea tours: compared to those on 48-month sea tours, those on 60-month sea tours were about half as sensitive to sea pay in their first year, and one-third as sensitive in their second year.

Golding and Gregory (2002) produced a weighted average of their results across all sea-tour lengths and across all years in sailors' sea tours and estimated that offering a $50 rise in sea pay to all sailors in their sample would translate into about 1,425 work-years of sea duty at a cost of $45 million. From these figures, they estimated that generating each additional year of sea duty would require $31,600 in CSP. The effect of CSP on sea duty was seen to operate through two routes: by increasing the proportion of their prescribed sea tour (PST) that sailors complete, and by increasing the likelihood that sailors would extend their current PST.

Given that the Golding and Gregory (2002) results are now 12 years old, we wish to update their estimates. However, with the resources available for this study, we are constrained from replicating the sort of extensive and detailed empirical analysis

[10] The independent variable was a binary measure of whether a sailor completed the indicated year of sea duty. All the coefficients on sea pay were statistically significantly different from zero at the 95-percent level. The authors did not test whether the coefficients were statistically different from each other.

undertaken by the previous authors. Instead, we consider how conditions have changed since the time of Golding and Gregory (2002) and try to infer how sailors' sensitivity to CSP is likely to have been affected by these changing conditions.

Six effects must be considered in updating the previous estimates: the impact of inflation; alteration in Navy extension policy; a trend towards longer initial enlistment contracts; longer sea tours; new detailing policies; and changes in the amount of sea pay offered to personnel in various paygrades and with different cumulative time at sea.

### *The impact of inflation*

Because the purchasing power of a dollar has deteriorated over the past 12 years, we need to account for the decline in the real value of the CSP over these years. This is a simple adjustment. Prices have increased by 32 percent over the past dozen years, and the additional year of sea-duty time that could be purchased for $31,600 in 2002 would now cost $41,412.

### *Changes in Navy extension policy*

Golding and Gregory (2002) found that a substantial portion of the additional sea time generated through increased sea pay came from sailors extending their enlistment contracts and completing more of their PSTs.[11] In January 2009, the Navy responded to recent sharp increases in retention by curtailing sailors' ability to extend their enlistment contracts. The service prohibited commanding officers from offering extensions to those in overmanned ratings without the approval of the Navy Personnel Command (NPC).[12] As of that date, 5 of the 69 ratings listed in the relevant NAVADMIN (007/09) were overmanned in "zone A" (0 to 6 years), 31 were overmanned in "zone B" (6 to 10 years), and 32 were overmanned in "zone C" (10 to 14 years). These ratings vary significantly in their sea intensity, and it is not possible to identify (within the constraints of this project) the extent to which the curtailment of extensions reduced the ability of sea pay to increase the time that sailors spend at sea. It seems likely, however, that the change would have resulted in sailors becoming less sensitive to sea pay.

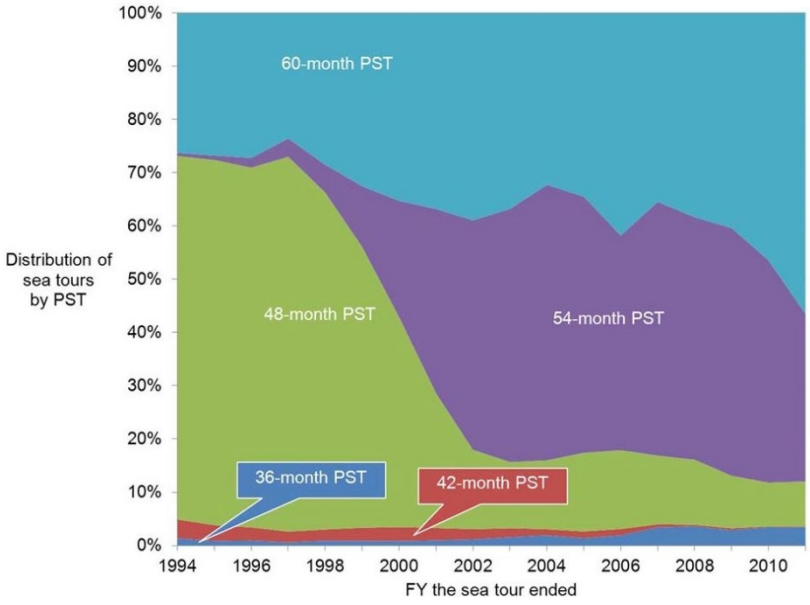
[11] The precise proportion of total additional sea duty that resulted from increasing sea tour completions could not be identified from the authors' description of their results. Because the authors do not distinguish what ratings sailors are in or what sea tour they are on, it is not possible to assess how their estimates might have been affected if they had been made under the service's current enlistment extension policy.

[12] Exceptions to the prohibition were made for those who needed to obtain obligated service in order to complete initial entry training, execute permanent change of station orders, and a few other instances. See NAVADMIN 007/09.

### *Changes in the length of sea tours.*

Over the past 12 years, the Navy average sea-tour length for those on their first sea tour has increased markedly (see Figure 9). Golding and Gregory (2002) suggest that the longest sea tours (5 years) are associated with the least sensitivity to sea pay. Considering only the longer sea tours, we would expect that a sailor's sensitivity to sea pay has been declining over the past 12 years.

Figure 9. Sea-tour length, first sea tour



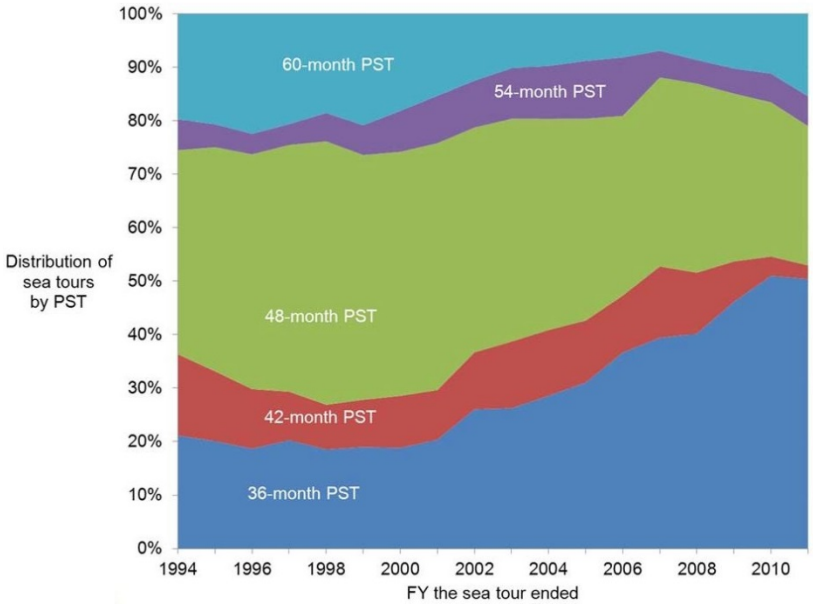

Source: McIntosh and Gregory (2013).

However, this may not be correct. There are essentially two reasons why the sailors on longer sea tours might have been less sensitive to sea pay: there was something inherent in longer sea duty that made it different from shorter sea duty, or there was something inherent in the sailors who serve on longer sea duty. Golding and Gregory (2002) assumed that the difference lay in the sea duty itself.[13] However, one should consider that, in the period that Golding and Gregory (2002) analyzed, longer sea duty was most generally undertaken by those sailors in the highest tech ratings (such as "nukes"). These sailors typically have the highest skills, perform the best on

[13] They wrote, "…but, then, why would the sailors on 60-month tours… be less responsive to sea pay? If sea tour lengths of 60 months are just too long, increases in sea pay may not be able to compensate sailors adequately, and little change in behavior might occur."

vocational aptitude tests, and are offered the most to reenlist in the service. They are known to have the highest completion rates among enlisted personnel. It is possible that these personnel are the most likely to think of sea duty as a binding obligation or that completing their sea tour is essential to the development of their careers.[14]

Figure 10. Sea-tour length for careerists




Source: McIntosh and Gregory (2013).

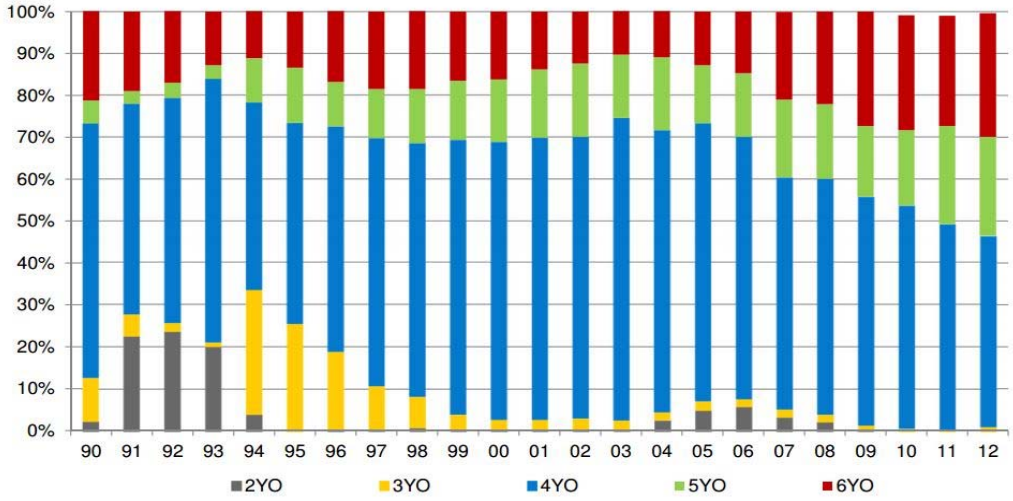
Even though, over the past 12 years, the Navy has moved many personnel from 4-year sea tours into 5-year sea tours, there has not been substantial change in the average skills background of sailors over this period. If the difference in sensitivity to sea pay is inherent in the type of sailors (rather than in the sea-tour length itself), we should expect to see this shift produce only modest changes in the average sensitivity to sea pay.

[14] There has been an opposite trend in sea tour lengths for careerists—those who are on their second sea tour or beyond. For these sailors, the average sea tour length has gotten significantly shorter (see figure 10). However, this trend is unlikely to offset the effects of longer sea tours for those on their first sea tour for two reasons. First, there are far fewer careerists on sea tours than first term sailors (careerist on sea tours are likely to be in their ninth year of service or beyond, and such long-tenured sailors make up only about one-third of the enlisted force). Second, sea tour incompletion rates are lower for career sailors, largely due to there being a lower likelihood of Navy losses among these personnel.

### *Changes in the length of the first enlistment contract*

Over the past 12 years, there has been substantial lengthening of the first enlistment contract (see figure 11). We believe that this has an indeterminate effect on sailors' sensitivity to sea pay. One of the principal reasons that sailors fail to complete their first sea tour is that they reach a reenlistment point prior to their PST and decide to depart the service. If the lengthening of first-term enlistments acts to extend sailors' EAOS dates so that they are closer to their PST, there would be less time after sailors' reenlistment decisions and before the end of their sea tour. However, if lengthening first-term enlistments serves to get more sailors to the end of their PSTs, it increases the opportunity for extensions of sea duty.

Figure 11. The length of first-term enlistment contracts




Source: Pinelis, Wenger, Huff, and Cox (2013).

### *Changes in sea pay across paygrades and cumulative sea duty*

As we mentioned, we argue that sea pay is likely to have little effect on the time that sailors spend at sea until they accept their first reenlistment. Although the Navy continues to provide sea pay to many who have not yet hit their first reenlistment point, the service has been letting the real value of sea pay decline for the most junior sailors. All else held constant, this would result in raising the average sensitivity to sea pay among sailors.

### *A change in detailing policy*

A recent change in how Navy detailing sets proected rotation dates (PRDs) has resulted in more sailors having the opportunity to remain on sea duty through the

end of their PST, and this, in turn, has worked to make sailors more responsive to sea pay. The mechanisms of these changes were described in McIntosh and Gregory (2013) who wrote:

> For first-term sailors…the policy for setting PRDs relative to PSTs [has] changed over time. Before April 2010, when new sea duty orders were written for a first-term sailor, his PRD was set equal to his PST or his EAOS, whichever came first…. In practice, this means that, even if a sailor whose PRD is set at his EAOS reenlists, there is still a chance he will not complete his PST because of the following chain of events. First, as that sailor's PRD approaches, a requisition is created to backfill his billet and new sea duty orders are cut for a sailor to take his place aboard that ship. But, if the sailor decides to reenlist, Navy practice is to honor the new orders written for the backfilling sailor and, therefore, new orders must be written for the reenlisting sailor. If the ship he is currently on is undermanned, then he might be written new orders to stay onboard. If not, the sailor should be written new orders to continue to serve at sea on a different ship for the time remaining until his PST. In practice, however, if the sailor has a year or less left until he reaches his PST, it is not considered worthwhile to issue new sea duty orders to a new ship (and potentially pay associated Permanent-Change-of-Station costs). Instead, the sailor will roll to shore early.
>
> Therefore, before April 2010, the interplay of Navy policy (setting a PRD equal to a sailor's EAOS when time to his EAOS is shorter than his PST) and Navy practice (rolling reenlisting sailors to shore early if they have a year or less left on to their PSTs) creates opportunities for [sea tour incompletions] among first-term sailors.
>
> Starting in April 2010, the policy for setting PRDs relative to PSTs for first-term sailors changed…. Specifically, when new sea duty orders are written for a first-term sailor, his PRD is set equal to his PST regardless of his EAOS. In practice, for a sailor whose time to EAOS is less than his PST at the start of his sea tour, this means that his reenlistment intentions are gathered as his EAOS approaches. If the sailor says he intends to reenlist, his PRD does not change (since it is already set at his PST). If the sailor says he intends not to reenlist, his PRD is moved back to his EAOS. This new policy limits opportunities for [sea tour incompletions] since no requisitions are created to backfill billets until a sailor declares that he does not intend to reenlist.

The policy change in 2010 reduced the number of sailors who failed to complete their sea duty for administrative causes (as opposed to failing to complete on their

own volition). As a result, more sailors remained on sea duty and were subject to being influenced by sea pay, increasing sailors' sensitivity to sea pay.

### *The likely net effect*

So, we must then ask the question: What is the likely net effect of these six factors on sailors' sensitivity to sea pay, and how can we extrapolate from the findings of Golding and Gregory (2002) to provide a quantitative assessment of career sea pay? The effect of inflation is unambiguous and easily quantified: higher prices have resulted in a 32-percent rise in the cost of generating a year of sea pay. This now stands at $41,412.

We cannot know the net impact of the other five effects, however. Two of these five effects—lengthening prescribed sea tours and changes in extension policy—could make sailors less sensitive to sea pay and, thereby, raise the cost of generating additional sea-duty time. One—lengthening of first term enlistment contracts—has an indeterminate effect. The remaining two factors—the change in sea pay across paygrades and the change in Navy detailing policy—would likely make sailors more sensitive to sea pay and act to lower the cost of generating additional sea-duty time. Because these five factors cannot be quantified (within the constraints of this analysis), and because they act in opposite directions, we will assume that these five factors act to confound each other. As a consequence, our best estimate of the cost of generating additional sea pay is simply the Golding and Gregory (2002) estimate adjusted for inflation: $41,412 per additional year of sea duty.

# Defining the effects of sea pay

In the previous section, we discussed the Golding and Gregory (2002) results that linked the amount of sea pay provided to sailors and the amount of time sailors spent on sea duty. Those estimates purported to capture two possible effects of sea pay on sailors' actions:

- Incentivizing sailors to complete their PSTs
- Inducing sailors to extend beyond their PSTs.

Because of the way the authors constructed their samples and their statistical models, however, their estimations of the first effect (completing the prescribed sea tour) actually captured the outcomes to three decisions:

- Deciding whether to reenlist in the service
- Attriting, or not attriting, from the Navy prior to EAOS
- Remaining on sea duty, conditional on remaining in the service (that is, conditional on neither attriting nor failing to reenlist).

In this section, we argue that sea pay is not a particularly effective instrument for inducing reenlistment or for inhibiting attrition, but that its principal purpose is to convince personnel who are committed to remaining in the service to remain on sea duty. We then consider how we can use the results of Golding and Gregory (2002) to estimate the effectiveness of sea pay in keeping sailors on sea duty when they are not facing reenlistment or attrition.

## Earlier work combines multiple effects

When evaluating the effects of CSP and CSPP and their return on investment, it is useful to consider both what these bonuses are intended to accomplish and their full effects on sailor behavior. The Chief of Naval Operations suggests that the intent of Congress in enacting these bonuses "is to provide a key distribution tool of the Navy

as well as provide a special payment in recognition of the greater than normal rigors of sea duty, the arduous duty involved in long deployments, and the repetitive nature of assignment to such duty."[15] The usefulness of these bonuses in distribution is in offering an incentive for sailors to complete their PST and/or extend beyond their PST.

Sea pay, however, has at least a theoretical potential to influence a wide range of behaviors including:

- Enlisting in the service
- Selecting a sea-intensive or shore-intensive rating
- Selecting longer terms of enlistment
- Taking an extension on the current enlistment
- Reenlisting for an additional term
- Completing the enlistment contract without attrition
- Remaining on sea duty, conditional on staying in the Navy.

Ideally, one would like to estimate how sea-pay bonuses affect both the *total* amount of sea time served and each of these individual decisions that combine to determine the total sea time served. The previous analysis of sea pay (Golding & Gregory (2002)) examined all sailors on sea duty and considered the effects of sea pay on the *aggregate* of three behaviors:

- How CSP affects sailors who are subject to attriting from the Navy in other words, the extent to which CSP results in these personnel completing their current enlistment contracts while remaining on sea duty
- How CSP affects sailors who might be EAOS losses prior to the end of their PST. In other words, the extent to which CSP results in these sailors reenlisting and then continuing to serve on sea duty
- How CSP affects sailors who have already committed to remaining in the service. In other words, the extent to which CSP results in these sailors remaining at sea, conditional on their having already decided to stay in the Navy.[16]

[15] OPNAVINST 7220.14, *Career Sea Pay and Career Sea Pay Premium*, December 24, 2005.

[16] Golding and Gregory (2002) also conducted a separate analysis of how sea pay affects reenlistment.

The authors found that, across all sailors on sea duty, sea pay had a small, positive, and statistically significant effect on these three combined behaviors.

This does not mean, however, that all three of the effects are small. The analytic approach of Golding & Gregory (2002) likely obscures what we believe is the most important effect of sea pay. Although sea pay has a theoretical potential to influence reenlistment and attrition choices, we suggest that these first two effects of CSP are likely to be negligible because sea pay is not designed to be an effective retention tool. (We explain this assertion in the text box below.). However, sea pay is likely to be far more effective in convincing personnel to stay at sea, given that they have already decided to remain in the Navy. (We argue that this should be viewed as the principal purpose of the CSP and the primary basis on which these bonuses should be evaluated.) By combining the two effects of CSP that are likely to be negligible (the effect on attrition and on reenlistment) with the third effect, Golding and Gregory (2002) likely obscures the impact that CSP can have on the amount of time that sailors spend on sea duty, given that they have decided to remain in the Navy.

## Sea pay is a poor retention tool

Career sea pay provides payments of up to $750 per month, but most eligible personnel receive less than $425. The bonus is paid to all sailors during an enlistment as long as they are performing eligible sea duty and regardless of whether they either complete their prescribed sea tour or agree to a subsequent reenlistment. This means that, at the time that sailors face their reenlistment decision, the CSP payments that they have received up to that point are likely to have no effect on their decision of whether to remain in the service.

The CSP payments that a sailor expects during the subsequent enlistment – the enlistment for which the sailor is signing a contract – may have an impact on a sailor's decision, but this effect is likely to be very small. To see this, consider a sailor who is in a first enlistment, who is on a first sea tour, and who, with 12 months left on his PST, faces a reenlistment decision. Suppose that such a person were offered an additional CSP of $125 (about a one-third increase in sea pay for the typical recipient); if he were to reenlist, he would earn an additional $1,500 over the next year.

One might be tempted to think of this amount as a reenlistment bonus because a sailor must reenlist to obtain this money. And, if this money were offered as an SRB, it would be equal to about a one-sixth multiple reenlistment bonus; the literature suggests that such an SRB would be associated with about a 0.42 percentage point rise in reenlistment (see Hansen and Wenger (2004)).

Notice, however, that the conditions under which CSPs are offered are very different than the conditions under which SRBs are offered. In order for our sailor to receive the CSP, he must agree to both reenlist and continue serving on sea duty. In contrast, when sailors are offered an SRB, they are obliged only to reenlist. (The literature on the effectiveness of SRBs is based on sailors who are on sea duty and shore duty – and among those on sea duty, many roll to shore very early in their next reenlistment contract.) As a result, one should expect monies offered as a CSP to have a much smaller effect on reenlistment than monies offered as an SRB.

# Sea pay is a poor retention tool (cont.)

We expect that sea pay would have an even smaller impact on attrition. Much attrition is involuntary and, therefore, would not be sensitive to monetary incentives. In a 2000 analysis, Larson and Kewley suggest the following as the principal factors driving first-term Navy attrition (few, if any, of which appear to be sensitive to monetary inducements):

1) Inadequate preparation for transition from civilian life to recruit training, including incorrect or unclear expectations of military life, and poor civilian physical conditioning and lifestyle.

2) Failure to adapt to recruit training for reasons such as low stress resistance, homesickness, malingering, and immaturity.

3) Discipline problems stemming from disrespect for authority and disobedience of rules and regulations.

4) Medical/physical problems, many of which were not detected during earlier medical exams.

5) Fraudulent enlistment.

6) Screening deficiencies, including failure to detect mental disorders and personality disorders.

7) Drug use.

# Deriving improved estimates

One can use the Golding and Gregory (2002) results, together with other information about sailors' enlistments, to derive estimates of how sea pay affects the willingness of sailors to remain on sea duty, conditional on their having decided to remain in the service. This estimate is important because it points to the possibility that the service can get much greater return from sea pay by limiting the types of sailors to whom it offers sea pay. (Later in this analysis, we argue that the Navy can get even greater "bang for the buck" from sea pays by better coordinating the use of CSP and SRBs.)

To derive our revised estimates, we separate the sailors in the sample used by Golding & Gregory (2002) into three exhaustive and mutually exclusive groups:

1. Those who, within a given year, faced a choice of whether to reenlist and who chose to exit the Navy.

2. Those who, within the given year, faced a choice of whether to attrite from the service and who chose to exit the Navy.

3. All other sailors who, within the year, chose to remain in the Navy and who then faced the decision of whether to serve at sea or to roll to shore.

Because all three of these groups would have received sea-pay bonuses in the time period investigated by Golding and Gregory (2002), all three groups were included in their sample, and the authors' estimates of the effects of sea pay on sailors' behavior captured the three effects that we discussed earlier:

- The effects of additional sea pay on persuading the first type of sailor to reenlist and to spend additional time at sea

- The effects of additional sea pay on persuading the second type of sailor not to attrite and to spend additional time at sea

- The effect of additional sea pay on persuading sailors to spend more time at sea, conditional on their having decided to remain in the Navy during the time period of interest.

The Golding and Gregory (2002) estimates produced an aggregate marginal effect estimated across all three types of sailors. We would like to decompose their aggregate marginal effect to derive an individual marginal effect for how sea pay

affects sailors remaining on sea duty, conditional on their having decided to remain in the service.

To derive such an estimate from the Golding and Gregory (2002) results requires some simple math. Let us denote the aggregate marginal effect derived by Golding and Gregory (2002) as $M_{Total}$. This is the amount of extra sea time derived from each sailor as a result of increasing sea pay by $1. Let us also designate the quantity of each of the three types of sailor as $Q_1$, $Q_2$, and $Q_3$. Finally, let us define $X_{Total}$ as the total number of *extra days* of sea time, across all sailors, resulting from a $1 increase in sea pay. These definitions allow us to write

$$(Q_1 + Q_2 + Q_3) * M_{Total} = X_{Total} \quad (1)$$

or

$$M_{Total} = X_{Total}/(Q_1 + Q_2 + Q_3) \quad (2)$$

The Golding and Gregory (2002) estimates provide us with $M_{Total}$ and $X_{Total}$. Work by McIntosh, Gregory, and Parvin (2014) provides us with estimates of $Q_1$, $Q_2$, and $Q_3$, and these allow us to derive a speculative estimate of the marginal effect of sea pay on the third group of sailors those who have committed to remaining in the service.

We rewrite (1) to reflect the individual marginal values for each group:

$$Q_1 * M_1 + Q_2 * M_2 + Q_3 * M_3 = X_{Total} \quad (3)$$

We assume that the marginals $M_1$ and $M_2$ can be written in terms of $M_3$ such that

$$M_1 = \alpha_1 M_3 \text{ and } M_2 = \alpha_2 M_3.$$

From this, we can write

$$Q_1 * \alpha_1 M_3 + Q_2 * \alpha_2 M_3 + Q_3 * M_3 = X_{Total} \quad (4)$$

or

$$M_3 = X_{Total}/(Q_1 * \alpha_1 + Q_2 * \alpha_2 + Q_3). \quad (5)$$

If, as we have argued, sea pay has only trivial effects on reenlistment and attrition (that is, if effects (i) and (ii) above are negligible), then both $\alpha_1$ and $\alpha_2$ approach zero and we can write

$$M_3 = X_{Total}/(Q_3). \quad (6)$$

We can compare this with equation (2). MacIntosh and Gregory (2013) suggest that Q1 + Q2 make up between 57 percent and 67 percent of the population of those on sea duty in '94 – '02. (That is, between 57 percent and 67 percent of those on sea duty failed to complete their PST because they either attrited or become EAOS

losses.) Given these figures (and our assumption that $\alpha_1$ and $\alpha_2$ approach zero), the marginal $M_3$ is between 2.3 and 3 times the marginal $M_{Total}$.[17]

To summarize this argument, we suggest that the principal purpose of the CSP (and the primary basis on which these bonuses should be evaluated) is to increase the amount of time that sailors spend on sea duty, conditional on their having decided to remain in the Navy. In order to estimate this effect, one should exclude from analysis those sailors who we know cannot be influenced by sea pay to extend their time on sea duty; we should exclude those who attrite or refuse reenlistment prior to the end of their PST.

This would mean excluding a large portion of the sample that Golding and Gregory (2002) examined. McIntosh et al. found that approximately 2/3 of sailors on their first sea tour either attrited from the Navy or were EAOS losses prior to their completing their sea tour. This means that only 1/3 of first-term sailors remain in the Navy through their PST (some of these sailors stayed on sea duty to the end of their PST, while others rolled to shore duty). It is this 1/3 of sailors we should include in our sample when assessing the effects of sea pay on sea duty.

We have not been able to re-run the estimations of Golding and Gregory (2002) while defining our sample in this way. However, we argue that, had we been able to do so, we would find that marginal effects of sea pay on sea duty for those not facing reenlistment or attrition are between 2.3 and 3 times the aggregate marginal identified in Golding and Gregory (2002).

[17] As a point of comparison, if $\alpha_1$ and $\alpha_2$ were both equal to 0.5 – that is, if the marginals $M_1$ and $M_2$ were half the value of $M_3$ – then the marginal $M_3$ would be between 1.4 and 1.5 times the value of $M_{Total}$.

# Coordinating SRBs and CSP

In considering possible reforms to sea pay, one must ask the essential question of military manpower and personnel management: how can we recruit, access, and retain people, train them, distribute them to where they need to be within the Service, and do all this without paying more than is necessary? In the previous section, we argued that essential elements in designing effective pays are (1) narrowly defining how a specific pay is supposed to impact sailors' behavior and (2) assessing the effectiveness of the pay in meeting its objective. Specifically, we argued that one should not expect Career Sea Pay to have much effect on sailors' reenlistment and attrition decisions, but that the effectiveness of the pay should be judged solely on how it affects sailors' willingness to perform sea duty conditional on prior reenlistment and attrition decisions.

In this section, we consider a reform to compensation that we believe has the potential to reduce both the cost of reenlisting sailors and the cost of keeping sailors on sea duty (or, viewed from an alternative perspective, it has the potential to keep costs at their present level while increasing both reenlistment and the time that sailors serve on sea duty). At present, these pays (or bonuses) are established and administered separately from each other, and this lack of coordination results in the pays being less effective than they might be. We posit a plan under which the Navy coordinates the SRBs and CSP pay that the Navy offers, and does this in such a way that the service learns more about the preferences of individual sailors and is better able to tailor payments to sailors, offering them only what is needed to induce their reenlistment and their continued time at sea. Moreover, the plan results in the Navy detailing to sea duty those sailors who have the least aversion to sea duty and assigning to shore duty those who have the greatest aversion to sea duty.

The policy we are considering is a type of "non-linear pricing" that is commonly used in the private sector to induce customers to reveal their true demand for a product. This mechanism allows companies to tailor prices to specific segments of their market and, in so doing, to maximize profits. An example will explain its usefulness in the private sector and help illustrate how the pricing mechanism might be applied in the Navy.

# An example of "non-linear pricing"

## *Wireless telecommunication*

Telecommunication companies know that, to maximize profits, they must provide service to both (1) "light users," those who use their wireless communication services at moderate levels (think of most ordinary consumers) and (2) "heavy users" (think of a Fortune 500 company). However, these wireless phone companies know that if they were to use a simple pricing mechanism (perhaps charging just a single price per gigabyte of data transfer for all customers), they would likely experience low levels of profits: they would be selling a large volume of service but would be selling each unit at a low price.

After many years of examining the demand for telephone service, telecommunications companies hit upon a simple but important observation. Light users are not interested in large volume discounts but are concerned only with incurring the lowest cost for the small amount of bandwidth they plan to use. Heavy users, on the other hand, are not interested in "special deals" that would offer discounts but constrain their usage; they are interested only in minimizing their costs over their *entire* use of bandwidth.

> *If you can figure out what motivates a person, it is much less costly to acquire their services and to induce them to perform.*
> *-- Mr. Frederick E. Vollrath, Assistant Secretary of Defense for Readiness and Force Management at a September, 2014 memorial for Walter Oi at the Center for Naval Analyses*

Telecommunications companies use this distinction to construct a market segmentation technique that is the heart of the non-linear pricing scheme we propose. Under the telephone company's pricing scheme, a plan is offered for "heavy users" that has a large "up-front fee" (an amount that is charged regardless of utilization), but that has a low "per unit" charge (a low price per gigabyte of data). A separate plan is also constructed for the "light users" that has a nominal "up-front fee" and a low per unit fee *up to some relatively low threshold level of utilization*; after a user reaches that threshold level, the per-unit fees are greatly increased.

Phone companies benefit from this non-linear pricing scheme in garnering more revenue from their heavy users; they collect the large "up-front" fees from these users, but are able to retain these customers by offering large discounts on

high- volume utilization.[18] Under this scheme, they also benefit from capturing more revenue from "light users"; these customers stay with the phone company because they generally pay low up-front costs and small per-unit costs on their low level of utilization, but they occasionally pay substantially higher per-unit costs when they exceed their threshold level of utilization.

This type of non-linear pricing scheme is assessed by its ability to raise firms' profits, and this, in turn, depends on the following factors:

- The plan's ability to induce self-selection among customers in such a way that reveals useful information about customers' demand.
- The degree to which it induces participation from various groups of customers.
- Its capacity to extract from customers what they are willing to pay for a good or service. One determinant of this capacity is whether customers select the plan intended for their market segment. For example, in our telecommunications example, the light user could not benefit from "gaming-the-system" and participating in the plan intended for the heavy user, and the heavy user could not profit by participating in the plan for the light user. Being able to identify the market segment of each customer is essential to extracting the full amount that they are willing to pay.

## Non-linear pricing for Navy pays

The Navy, of course, is not a private company that is trying to maximize profits by figuring out how much various classes of customers can afford to pay for their product. The service does, however, face an analogous problem that can be solved with non-linear pricing. Sailors do not willingly reveal the minimum amounts they are willing to accept in order to reenlist and perform greater sea duty. Because everyone likes to be paid "economic rent,"[19] no one willingly reveals their "reservation wage".[20] If the Navy could determine how much it must pay various groups of sailors to induce their reenlistment and to continue on sea duty, it could potentially enjoy large savings in compensation.

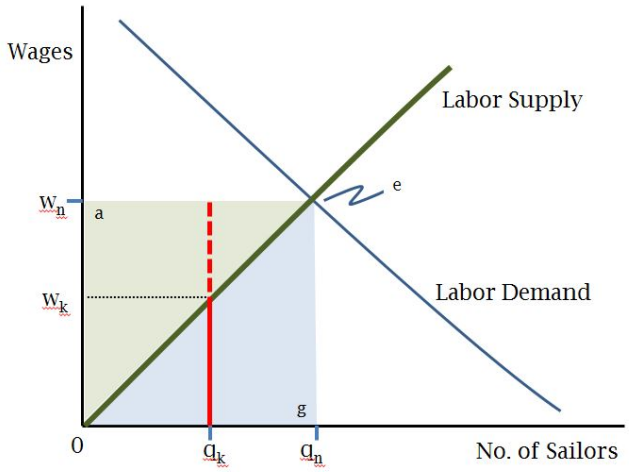
[18] Phone companies are able to heavily discount high-volume utilization while still remaining profitable because marginal costs in the telecommunications industry are very low.

[19] "Economic rent" is the payment a person receives for doing a job in excess of what is necessary to secure that person's services.

[20] The "reservation wage" is the minimum amount that a person must be paid in order to secure his services for some period of time.

Figure 12 shows a simple representation of the market from which the Navy draws its labor (think of this as the supply of sailors who may be willing to reenlist depending on the bonus). One can think of such a labor supply curve as consisting of all the reservation wages of people in the labor market. For example, if the service wished to secure the reenlistment of just one sailor, the person denoted $q_k$, it would have to pay the reservation wage $w_k$. However, if the Navy wished to acquire the services of all those in the labor market from 0 to $q_n$ (including $q_k$), and if it were limited to offering only a single wage (or bonus) to all those in the labor market, it would need to offer $w_n$. The Navy's wage bill for acquiring $q_n$ units of labor at a cost of $w_n$ would then be $q_n * w_n$, or the area of the rectangle 0aeg.

Figure 12. A simple example of the Navy paying "rents" in the labor market




This wage $w_n$ is that which is necessary to induce the "marginal labor market participant" (that person denoted at $q_n$) to offer his labor services. However, the wage $w_n$ is *more* than is necessary to secure the services of all intra-marginal market participants, i.e., those represented in the figure to the left of $q_n$ (from 0 to $q_{n-1}$). In this illustration, the dashed red line with length $w_n - w_k$ is the "economic rent" earned by person $q_k$ (i.e., the amount paid in excess of what is necessary to secure the services of the person represented by $q_k$) and the green triangle 0ae is the economic rent paid by the Navy to secure the services of all those in the labor market from 0 to $q_n$.

If the Navy were able to induce those in the labor market to reveal their reservation wage, and if the service were able to extend to people individual offers that were equal to their reservation wage, the service could acquire the labor force it requires without paying rents. In such a case, the wage bill would be just the triangle 0ge.

Although there is no mechanism that would reveal the *precise* reservation wages of labor market participants, we can construct a revelatory price mechanism that may help make a significant reduction in the rents paid by the Navy. As we explain later in this study, we accomplish this using a market-segmentation technique similar to that employed in the non-linear pricing scheme of the telecommunications companies.

## A proposed non-linear pricing mechanism

Once sailors are recruited, trained, and detailed to their initial billets, much of the Navy's compensation costs are focused on two objectives: retaining personnel and ensuring that those on sea duty remain at their sea billets. As we have previously observed, these two objectives are currently addressed by offering pays (bonuses) that are managed independent of each other: SRBs and CSP. Because they are managed independently, the service ends up paying significantly greater rents than necessary in meeting its retention and sea manning goals (this is explained in a later figure). However, it is possible that the Navy could significantly reduce the rents it pays for retention and sea manning if it were to use non-linear prices to set its SRBs and CSP schedules jointly. This could be done in a way that induces sailors to reveal their preferences for both general military service and time spent at sea, and that allows the Navy meet its manpower requirement needs while paying fewer rents.

In the telecommunications example above, we showed how a cell phone company can use non-linear pricing to reveal customers' demand for cell phone service. Here, we illustrate how a buyer of labor services (the Navy) can use a similar non-linear pricing mechanism to reveal sailors' reservation wages—the amount that different groups of sailors would have to be paid to induce them to reenlist or to continue on sea duty. (A detailed example of the non-linear pricing scheme is provided in the appendix of this analysis.)

### *Assumptions*

To explain this compensation mechanism, we start with some basic assumptions:

- Sailors can separate their preferences for Navy service into two elements: sea duty and all aspects of Navy service other than sea duty.
- Sailors know their own reservation wages for both reenlistment and serving in sea duty for any given length of time.
- The Navy has a good estimate of the supply curve for sailors—how much SRB would have to be offered to secure the reenlistment of various numbers of sailors. (This seems like a reasonable assumption given the service's history of fashioning reenlistment bonuses.)

- The Navy also has a good estimate of how much CSP it must offer to induce sailors to spend various amounts of time at sea.

- We are considering a group of sailors (perhaps a particular rating/paygrade combination) for which there are both sea billets and shore billets.

### *Partitioning the market*

The pricing mechanism offers bonuses that are meant to partition sailors into three exhaustive and mutually exclusive types:

- *Type 1:* sailors who have a relatively low reservation wage for general Navy service, but who have a relatively high reservation wage for sea duty. (These sailors take a relatively low level of disutility from general Navy service but a relatively high level of disutility from sea duty.)
- *Type 2:* sailors who have a relatively high reservation wage for general Navy service, but who have a relatively low reservation wage for sea duty. (These sailors derive relatively high disutility from Navy service in general, but a relatively low level of disutility from sea duty.)
- *Type 3:* sailors who have high reservation wages for both general Navy service and sea duty.

(There are, of course, sailors who have low reservation wages for both general Navy service and sea duty, but these personnel will be sorted into one of the first two groups depending on the relative magnitude of their two reservation wages.)

### *The offers made to sailors*

Under the non-linear pricing mechanism that we are positing, the Navy would offer all sailors a choice of two plans, each of which has three elements.

Plan I

(a) A relatively low reenlistment bonus. Only a modest SRB would be needed to induce sailors to reenlist.

(b) A relatively high sea-duty pay per month. A high per-month sea-duty pay would be necessary to compensate these personnel for the high disutility they take from sea duty. However, these personnel would be permitted to serve a relatively shorter period of time on sea duty. (The ceiling on sea duty for this group is necessary to ensure that sailors choose the compensation package that is intended for them.)

(c) A relatively lower requirement for sea duty. Sailors who accept this plan are constrained by a ceiling on the amount of sea duty they serve.

Plan II

(a) A relatively high reenlistment bonus

(b) A relatively modest sea duty pay (per month)

(c) A relatively high requirement for sea duty. (Sailors who accept this plan commit to a high level of sea duty.)

(Again, see the appendix for a more detailed example.)

### *Extending the analogy of the telecommunications example*

To understand how sailors would view these plans, the relative advantages of these plans to different types of sailors, and the benefits the plans would confer on the Navy, it is useful to think of our sailors as having characteristics somewhat analogous to the cell phone users we described earlier.

Type 1 sailors can be thought of as being somewhat like the light users of telecommunications services. Just as light users want a phone contract but do not expect to make much use of the phone service, type 1 sailors are willing to reenlist in the Navy if offered a modest SRB, but they do not wish to provide much sea duty (unless offered large amounts of sea pay).

Type 2 sailors can be thought of as being akin to the heavy users of telecommunications services in that they are the "high volume" participants. They do not care as much for the Navy in general, but if they can be compelled to reenlist, they would not have to be paid much sea pay in order to induce them to spend lengthy periods on sea duty. One might have to pay a substantial SRB to induce these sailors to reenlist, but once they have committed to remaining in the service, they would take significant benefit from receiving a modest sea pay per month for an extended period (given that this sea pay is set at a level that more than compensates for the relatively small disutility they take from sea duty).

### *How sailors would view the plans, and sort themselves*

The two plans described earlier could induce sailors to reveal to which class of sailor they belong (to reveal their preferences regarding sea duty and general Navy duty). If the two plans are priced appropriately (if the level of SRB and CSP are correctly set), we should observe sailors behaving in the following ways:

(1) Type 1 sailors (those who take relatively low disutility from general Navy service, but relatively high disutility from sea time), would choose Plan I. The relatively low SRB associated with this plan would more than compensate for the modest disutility they would take from reenlistment into general Navy service. Moreover, the high CSP offered under this plan would compensate for the high level of disutility this group takes from sea duty. Of critical importance is the fact that these sailors would be limited to serving relatively less sea duty under normal "peacetime operations." (As we explain below, this threshold is essential to precluding sailors in group 2 from

selecting Plan I in order to order to collect, over an extended period, the plan's higher sea pay.)

Note that the pay offers associated with plans I and II would be set so that type 1 sailors would not wish to choose Plan II. Although type 1 sailors would be attracted by the larger SRB associated with Plan II, they would be even more repelled by the plan's relatively low sea pay and the longer commitment to sea duty.

(2) Type 2 sailors (those who take relatively higher disutility from general Navy service, but relatively lower disutility from sea time) would choose Plan II. The high SRB associated with this plan would compensate these personnel for their reenlistment. And, even though the CSP would be set at a relatively modest level, it would be set to *more* than compensate these sailors for the relatively low disutility that they take from sea duty. Of critical importance to the success of this scheme is that prices under these plans would be set so that type 2 sailors would be attracted by the relatively *high* level of sea duty that is demanded of them under this plan. Because CSP *more* than compensates for their disutility resulting from sea duty, the more sea duty they undertake, the better off they would be.

Prices and service constraints would also be set so that type 2 sailors would not choose Plan I over Plan II. They would not like the lower SRB associated with Plan I, and, although they would be attracted to the relatively high level of monthly sea-pay payments, they would not like the fact that sea duty is capped at a lower level (precluding them from earning many months of the higher sea pay).

(3) Type 3 sailors (those who take high disutility from both general Navy service and sea duty) would choose neither of the two plans but would elect to leave the Navy.

## What are the sources of savings?

Up to now, we have asserted that a non-linear pricing mechanism can be constructed with reenlistment bonuses and sea pay set so that sailors reveal their relative preferences for either sea duty or general Navy service. However, we have not shown how the Navy could derive savings from employing a non-linear pricing mechanism.

### *The first source of savings: consolidating an inefficient process*

One source of possible saving would derive from consolidating the current two-stage decision-making process for SRBs and CSPs into a single, and potentially more efficient, single-stage process. At present, the process of reenlisting sailors is administered separately from the process of promoting sea duty with CSPs. These processes are administered sequentially: first sailors are offered SRBs to induce reenlistment and then, for those who accept reenlistment, the service assigns some sailors to sea duty and provides them with CSP (over the term of their sea duty,

sailors either continue accepting CSP, or they roll to shore). This approach results in the Navy paying higher rents than necessary.

To illustrate this, consider figure 13, in which we represent sailors' preferences for general Navy service and sea duty. Here, the top blue bar represents the disutility associated with general Navy service for 32 sailors who are eligible for reenlistment. These 32 sailors are arranged by the magnitude of their disutility, from least on the left to the most on the right. Also shown in this graph is the disutility associated with sea duty for these same sailors. For illustrative purposes, we assume that we make the rather unrealistic assumption that sailors' tastes for general Navy service are perfectly correlated with their taste for sea duty.[21]

We also make five other assumptions:

- The Navy wishes to reenlist 24 of the 32 sailors shown in this figure.
- From these 24 reenlisted personnel, the Navy wants 12 sailors to undertake extensive sea duty during their next enlistment.
- Sailors are risk neutral.
- Sailors have a zero discount rate.
- Only after sailors reenlist does the Navy assign personnel to sea duty or shore duty. (In our example, sailors do not know at the time of reenlistment whether they will be among the 12 personnel selected for sea duty.) In figure 13, the sailors who are randomly chosen for sea duty are denoted with an "X."

In order to secure the reenlistment of any individual sailor, the service would have to offer an SRB sufficient to offset the disutility of general Navy service, plus an amount sufficient to offset the *expected* disutility from being assigned sea duty. When the likelihood of being assigned to sea duty is 0.5 (or a 50-percent chance), the SRB necessary to secure the reenlistment of individual *i* is

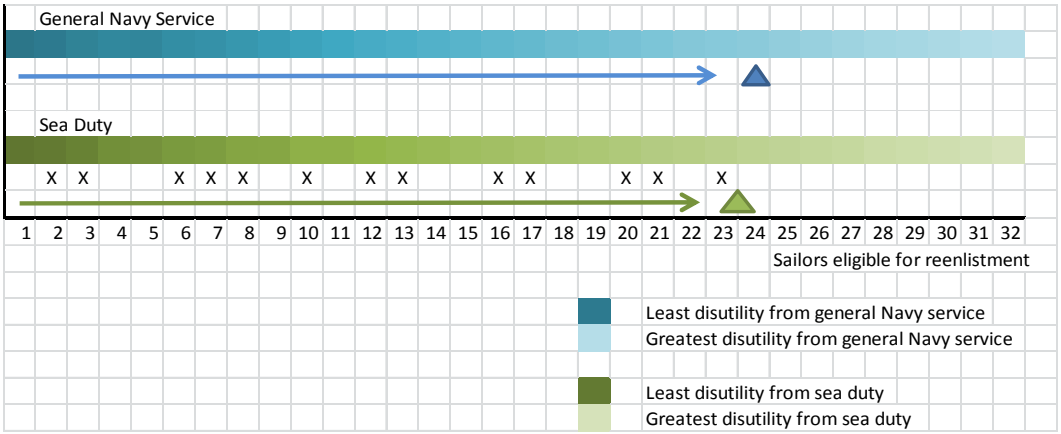
SRB necessary to secure services of sailor *i* =

Disutility of general Navy service for sailor *i*

+ (0.5) * Disutility of sea duty for sailor *i*

[21] The non-linear pricing scheme we propose actually requires that, across personnel, the disutility taken from general Navy service is less than perfectly correlated with the disutility taken from sea duty (the greatest potential savings from non-linear pricing occurs when these are negatively correlated). However, this is not germane to the point we are making in the current example.

Figure 13. When disutility of general Navy duty and sea duty are perfectly correlated




The important point to note here is that, if the Navy had a mechanism for identifying sailors' preferences for sea duty, it could assign to this duty those 12 personnel who take the least disutility from going to sea. However, as the service's detailing is currently administered, the Navy randomly assigns sailors to sea duty. In such a case the SRB amount necessary to induce 24 sailors to reenlist works out to be[22,23]

SRB necessary to secure services of sailor 24 =

Disutility of general Navy service for sailor 24

+ (0.5) * (((Disutility of sea duty for sailor 23)+(Disutility of sea duty for sailors 14))/2)

Although offering this amount in an SRB would be sufficient to secure the *reenlistment* of 24 sailors, it would not be sufficient to secure the *completed sea tours* for all 12 personnel. Sailors would be willing to reenlist for this SRB before they know whether they would be assigned to sea duty (when there is a 50/50 chance of such an outcome and sailors are risk-neutral). However, once the random assignment is complete, there would likely be sailors who are assigned to sea duty

[22] In repeated random trials with a 0.5 probability of being assigned to sea duty, the most likely outcome would have the sailors with either the 23rd or 24th lowest disutility from sea duty assigned to sea duty.

[23] We assume here that both the SRB and sea pay are disbursed over the term of reenlistment in such a way that sailors are induced to complete both their enlistment and their sea duty assignments.

for whom this amount is not sufficient to induce them to *complete* their sea tour. To secure the completed sea tours of all 12 sailors would likely require the payment of an additional sea pay equal to

Additional pay necessary to secure completed sea tours for 12 sailors =

(0.5) * (((Disutility of sea duty for sailor 23)

+(Disutility of sea duty for sailors 14))/2)

This example illustrates one of the benefits of non-linear pricing: it would induce sailors to reveal their preferences for sea duty and general Navy duty and would allow the Navy to assign to sea duty those sailors who take the lowest disutility from this type of service. This, in turn, would allow the Navy to achieve desired levels of reenlistment and completed sea tours while paying fewer rents and maintaining a smaller compensation budget.[24]

### *A second source of savings: shaping the force*

A second source of potential savings under a non-linear pricing mechanism derives from the Navy being able to set its bonuses in such a way that it does not end up with too many sailors in a particular community who want to be in the Navy – but do not want to go to sea (or too many who wish to go to sea, but who are stuck on shore). The non-linear pricing mechanism can be adjusted to:

1) Increase or decrease the total number of personnel who commit to reenlistment. By altering the overall value of the SRB and CSP across both plans, the service could alter the number of sailors wishing to reenlist. In the short run, this number is constrained by the current population in the rating or community who are eligible for reenlistment. However, over the long term, there would be no bound on the size of the population that can be attracted with greater overall compensation.
2) Change the *mix* of personnel who commit to reenlistment. By adjusting the three elements of the two plans, the Navy can adjust the proportion of sailors of each type (those who prefer shore duty and those who favor sea duty). In the short run, changing the mix may be expensive; given any existing

[24] There are other pricing mechanisms that could induce sailors to reveal their preferences for sea duty. For example, the Navy might hold an auction for sea assignments among those sailors who reenlist. However, non-linear pricing offers features that auctions do not. In requiring sailors to make *joint* decisions about reenlistment and sea duty, non-linear pricing offers the opportunity for the service to fine-tune the proportion of sailors in a community who favor sea duty with a bonus (and the proportion who favor shore duty without a bonus). In addition, the revelatory mechanisms of non-linear pricing would enable the service to reduce the rents it pays to induce both reenlistment and shore duty (an auction would permit the service to lower rents only on sea duty assignments).

population of sailors eligible for reenlistment, it would be possible to induce everyone to volunteer for sea duty (shore duty) if Plan II (Plan I) were made attractive enough. Over the long term, however, changing the mix of those taking Plan I or Plan II would be less costly; if a particular rating or community has unusually attractive terms for those who prefer sea duty, more sailors with these preferences would select into this rating over time, and, as a result, the Navy would be able to gradually bring sea duty incentives for this population back in line with other sea-duty-intensive communities.

### *Recapping the benefits*

At this point, it is worth recapping some of the benefits that could accrue to both the service and to Navy personnel from the introduction of a non-linear pricing scheme:

- The scheme induces sailors to voluntarily sort themselves by their willingness to undertake sea duty.
- The Navy would assign to sea duty those sailors who are most disposed to sea duty.
- In assigning sailors to shore duty and sea duty based on their preferences, the service would be able to reduce the overall rents it pays to persuade people to reenlist and to serve at sea.
- By adjusting the elements of the two plans offered sailors, the Navy would be able to both adjust the number of people reenlisting into a community and fine-tune the proportion of sailors who favor sea duty and the proportion who favor shore duty. This fine-tuning may enable the service to reduce the total number of personnel they must reenlist in order to send any given number of personnel to sea.

## Where would the savings be found?

Although a non-linear compensation scheme has the potential to produce significant savings for the Navy when it is used appropriately, not every sailor should be offered the compensation choices associated with non-linear pricing. The pricing scheme would likely not be appropriate for those communities that are able to meet their reenlistment goals without the use of SRBs. Also, the approach would be most easily implemented for those personnel who have the potential of rolling to sea for an extended period shortly after reenlistment; this is most likely to be the case for sailors who are facing their second reenlistment. (At present, most sailors are scheduled to roll to shore shortly after their first reenlistment point, and it does not make sense to offer personnel compensation tied to sea duty when they are prescribed an extended period ashore.)

In general, a non-linear pricing scheme has the greatest potential for producing savings in communities for which there are significant proportions of both sea-duty billets and shore-duty billets. Moreover, the savings from this pricing scheme would be greater in populations in which preferences for sea duty and general Navy service are less correlated. (That is, the savings are greatest when those who like the Navy most are generally disinclined to sea duty, and those who like sea duty are disinclined to other types of Navy service.) This last condition would likely pertain in cases where the Navy finds it relatively easy to induce personnel to reenlist, but then finds it difficult to induce the reenlisted sailors to complete prescribed sea tours.

# Implementation

## *In the short run*

Implementing non-linear pricing could be done in a way that would not disrupt either fleet manning or service-wide manning. Within a given community, the two plans offered under non-linear pricing could initially be set with options similar to each other and similar to existing prices for SRBs and CSPs. (Consistent with this, the threshold for maximum sea duty associated with "Plan 1" could be set close the current prescribed sea tour for the community.) Over time, greater and greater distinctions could be introduced between the plans, inducing greater self-selection in the two groups, reducing the overall level of rents that are paid by the Navy, and cutting the combined costs of reenlistment and sea-pay programs. Making incremental changes in this way would limit the risk of the Navy suffering manning shortfalls with the implementation of the pricing mechanism and would permit sailors to gradually become familiar with the program (and to face little risk of suffering regret from selecting an option that they ultimately come to understand is not optimal for them).

## *A challenge in detailing*

Implementing non-linear pricing would require changes in the way the Navy details personnel. Under this pricing scheme, the service would have to keep track of who opted into each of the plans and would have to ensure that sailors were sent to sea or shore with the appropriate tour lengths.

## *A possible extension for "hard case" ratings*

We previously mentioned that, under the Navy's current sea/shore flow pattern, it would not be practical to offer non-linear pricing to those at their first reenlistment point (these personnel are generally close to rolling to extended shore duty and it would not make sense to tie a substantial portion of their compensation to sea duty). However, it might be practical to employ non-linear pricing for first-term reenlistments in exceptional "hard case" ratings. At various times, the Navy has

suffered significant under-manning at sea in certain critical ratings. Although the Navy has recently viewed a minimum guaranteed shore tour as an essential right for sailors in peacetime, when there are critical shortages of personnel in sea billets, the service might wish to explore the possibility of offering a limited number of personnel at their first EAOS the option of reenlisting into a sea-duty tour. Using non-linear pricing would ensure that sailors could be induced to volunteer for such "back-to-back" sea tours at minimum cost.

# Conclusion

In this study, we considered three related issues. The first provided an update to previous estimates of the amount of sea duty that can be gained from a rise in Career Sea Pay – work originally undertaken by Golding and Gregory (2002). We identified several conditions that have changed since the earlier work that may have affected sailors' sensitivity to sea pay: inflation, a lengthening of prescribed sea tours, a lengthening of first enlistment contracts, changes in extension policy, changes in the relative sea pay across paygrades, and changes in Navy detailing policy. Our best estimate is that generating an additional person-year of sea duty would require an increase of about $41,000 in CSP expenditures. Our analysis also considered the effects of the CSPP and concluded that this bonus, which is more targeted than CSP, is likely to have a larger impact – dollar for dollar – than CSP.

The second issue we considered was how to separate multiple effects of sea-duty pay that have been intermingled in previous estimates: the effect of sea pay on reenlistment, the effect of sea pay on attrition, and the effect of sea pay on time spent on sea duty, conditional on remaining in the Navy. We argued that the first two of these effects are likely to be negligible and that the third effect is likely to be much greater than one might infer from previous estimates.

Our analysis also suggests an alternative method for combining sea pay with reenlistment bonuses. We demonstrate a non-linear pricing scheme that would induce personnel to reveal important information about their willingness to reenlist and their willingness to undertake sea duty. Under this pricing mechanism, the Navy could fashion combinations of SRBs and sea pays that would achieve the service's reenlistment and sea-duty goals at less cost than the current compensation scheme. It would also allow the service to assign to sea duty those sailors who are most disposed to sea duty (and assign to shore duty those who are most disposed to shore duty). Finally, the non-linear pricing scheme would permit the Navy to both adjust the number of people reenlisting into a community and fine-tune the proportion of sailors who relatively favor sea duty and the proportion who relatively favor shore duty. This fine-tuning may enable the service to reduce the total number of personnel it must reenlist in order to send any given number of personnel to sea.

Our work gives rise to the following policy recommendations:

- To induce sailors to spend greater time at sea, the Navy should target sea pays at those who are most sensitive to these bonuses. This means directing these

pays to sailors who are least likely to be facing reenlistment or attrition; these pays should be increasingly targeted at more senior sailors with greater time at sea.

- To produce greater sea time per dollar of sea pay, the service should, where practical, make greater use of closely targeted pays such as Career Sea Pay Premium, and Sea Duty Incentive Pay.
- The Navy should gradually implement a non-linear pricing scheme for more senior personnel (e.g., those enlisting into a second sea tour) in a small number of communities that have significant requirements for both sea and shore duty. The service should then assess the effectiveness of these pilot programs and consider implementing this type of non-linear pricing more widely across the Navy.

# Appendix: An example of non-linear pricing

In this appendix, we provide an example of the non-linear pricing scheme described in the body of the text. Our example illustrates how this type of pricing mechanism induces sailors to reveal their preferences for sea duty and general Navy service by self-selecting into one of two combinations of SRB and sea pay. The example also demonstrates that, under such a compensation plan, those service members who are most inclined to sea duty would be those to whom the Navy assigns the greatest amount of sea duty. Finally, the example shows how savings could be produced under such a scheme.

## Assumptions

### Assumption 1

Suppose that one can decompose the disutility associated with serving in the Navy into two factors:

- The disutility associated with serving at sea.
- The disutility associated with all other aspects of serving in the Navy (this may include foregone income from alternative employment, foregone leisure, relative taste for all other aspects of military life).

### Assumption 2

Suppose further that there are two types of sailors:

Type A sailors (half of all sailors) have relatively low aversion to Navy service in general, but are more averse to sea duty.

Type B sailors (half of all sailors) are relatively more averse to Navy service in general, but are less averse to sea duty.[25]

We assign values to sailors' utility (disutility) and to the amounts of compensation needed to induce reenlistment and voluntary acceptance of a year of sea duty. These values are meant only to be illustrative.

| | Disutility associated with reenlisting to general Navy service | Disutility associated with a year of sea duty |
|---|---|---|
| Sailor A | -$6.00 | -$1.00 |
| Sailor B | -$10.00 | -$0.33 |

## Assumption 3

The service would like to be able to distinguish between these two groups in order to accomplish two things:

- Direct type A sailors more towards shore duty and type B sailors more towards sea duty. (Assigning people to the jobs they dislike the least not only maximizes the wellbeing of the force, but may also allow the Navy to induce voluntary sea duty at the least cost.)
- Tailor SRBs and sea-duty pay as close as possible to sailors' preferences so that it can induce reenlistment and voluntary sea duty at the minimum cost (so that it can minimize the amount of rent that is paid to sailors).

## Assumption 4

In a particular rating, the Navy needs 2/3 of its sailors to be on sea duty at any time (this is sea-centric, but the numbers are useful as an example).

[25] We need not worry about sailors who are highly averse to both general service and sea service. These sailors wouldn't serve under any reasonable levels of compensation and are excluded from our example. On the other hand, those personnel who have low aversion to both general Navy service and sea duty are defined to be either Type A sailors or Type B sailors, depending on the relative magnitudes of their two levels of disutility.

## Assumption 5

The Navy offers two plans to its sailors in order to induce self-selection and minimize costs of achieving reenlistment and sea-service goals:

Plan 1: \$7 to reenlist to a 6-year contract; \$1 per year paid for serving at sea with a limit of 2 years on sea duty.

Plan 2: \$10+δ to reenlist to a 6-year contract (where δ is a small number close to zero); \$1/3 per year paid for serving at sea with the expectation that 6 years of this contract will be served in sea duty.

# Self-selection and savings

## Stable self-selection

As we discussed in the body of this analysis, for this scheme to be viable, it needs to meet three criteria: (1) that one of these plans will be acceptable to both types of sailors, (2) that sailors will select the plan that is intended for them (that will minimize costs to the Navy), and (3) that, when each type of sailor selects the appropriate plan, the Navy enjoys a savings relative to the least costly single-price plan it could offer to induce the needed reenlistment and the necessary voluntary sea-duty participation.

We demonstrate how the plan meets these criteria with the following steps:

I) Figuring out which plan a type A sailor would choose.

The amount paid under Plan 1:

\$7 + (2 years)*\$1 = \$9

The disutility associated with taking plan 1 for sailor A:

-6 + (2 years)*(-1) = -8

The amount paid under Plan 2:

\$10+δ + (6 years)*\$1/3 = \$12+δ

The disutility associated with taking plan 2 for sailor B:

-6 + (6)(-1) = -\$12

Note that the amount paid under Plan 1 ($9) would more than compensate for the disutility that type A would experience were he or she to take this plan (-$8). The amount paid out under Plan 2 ($12+δ) would also compensate for the disutility that type A would experience were he or she to take this plan (-$12), but only just barely. Type A sailor would choose Plan 1 because it offers greater compensation against disutility.

II) Figuring out which plan a type B sailor would choose.

The amount paid under Plan 1:

$7 + (2 years)*$1 = $9

The disutility associated with taking Plan 1 for sailor B:

-10 + (1/3)(-2) = -10.66

The amount paid under Plan 2:

$10+δ + (6 years)*$1/3 = $12+δ

The disutility associated with taking Plan 2 for sailor B:

-10 + (6)(-1/3) = -$12

So, the bottom line is that the amount paid under Plan 1 ($9) is not adequate to offset the disutility that a type B sailor would experience were he or she to take this plan. However, because the amount paid out under Plan 2 would more than compensate for the disutility that the type B sailor experiences from taking this plan, he or she will want to take Plan 2.

## The revelatory mechanism

So, we see that self-selection works under this example. Sailors reveal their preferences and pick the plan that minimizes costs to the Navy. Now, let's compare the amount that would be saved were the Navy to offer these two menu plans in place of the least expensive single-menu offering that would meet both its retention and sea-duty goals.

Suppose that the Navy needs to retain 120 sailors, have 2/3 at sea, and have all compensated for the disutility of performing sea duty (so that the 80 sailors needed at sea will voluntarily sign up for sea duty).

# Savings

## *Cost under proposed scheme*

Under the multiple-choice pricing option, this would be achieved at the following cost:

The 60 sailors who are type A would choose Plan 1 at $9 each for a total cost of $540.

The 60 sailors who are type B would choose Plan 2 at $12+δ for a total cost of $720 + $60δ.

Therefore, under the multiple-choice pricing option, the cost of meeting both the retention and sea-duty manning goals would be 1,260 + $60δ. The per-sailor cost would be (1,260 + $60δ) / 120 = $10.50 + 0.5δ.

## *Cost under existing scheme*

At present, when all sailors get paid the same and all sailors face an expected time at sea of 4 years (2/3 of the 6-year contract), reenlistment bonuses would have to be set as follows:

Type A sailors would reenlist only if offered more than $6 + (4)$1 = $10.

Type B sailors would reenlist only if offered more than $10 + (4)$1/3 = $11.33.

Because both types of sailors would have to be paid the same, all sailors would have to be paid $11.33 if the service is to meet its reenlistment and sea-duty goals. Thus, the Navy would have to bear a cost 8 percent more per sailor than under the multiple-choice scheme (compared to the average of $10.50 under the multi-price scheme).

## *An added consideration*

The cost advantage for the proposed scheme *may* be even greater than 11 percent. This comes down to the question of whether sailors would attrite from the service if, at any moment, they find the expected value of future payments from a plan to fall below the expected disutility associated with fulfilling the obligations of that plan. (This is the same question one faces in analyzing the need for lump-sum payments of SRBs: Does there always have to be a sizable financial carrot in front of the sailor?)

Notice that, to secure the reenlistment of our type B personnel, one needs to offer $10 "upfront" at the beginning of the reenlistment. This means that $1.33 of the uniform (single price) $11.33 payment is available to be paid out over the 4 years of sea duty in order to secure sailors' voluntary service on sea duty. This amounts to

paying $0.33 per year for each of the 4 years of sea duty. But observe that our type A sailors experience disutility from sea duty that is greater than what can be offset by a $0.33 annual payment. They require $1 per year to be "made whole." If, as at present, the Navy does not recoup SRBs from sailors who fail to complete their term of reenlistment, one could imagine that our type A sailors might pocket the $10 SRB (an amount significantly more than the disutility they associate with general Navy service) and leave the Navy when they are sent to sea duty, because the $0.33 annual payment is not sufficient to cover the $1 disutility per year that these type A sailors take from sea duty.

If sailors think this way, it would be necessary, under a uniform pricing scheme, to increase annual sea pay by $0.67 per year for all sailors (so that the total annual sea pay is $1 and is enough to offset the disutility of sea duty for the type A sailors). In such a case, the minimum cost the Navy would have to bear to secure all necessary reenlistments *and* full voluntary participation in sea duty (under a single-price plan) would be 11.33 + 4 * $0.67 = 14.01. This would mean that the single-price scheme would be 33 percent more expensive than the multi-price scheme.

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