



# Policies for Managing Reductions in Military End Strength

Using Incentive Pays to Draw Down the Force

Michael G. Mattock, James Hosek, Beth J. Asch

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## Preface

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Policy changes periodically call for military force downsizing. A major decrease in force size occurred at the end of the Cold War, the Navy downsized in the previous decade, and the Army and Marine Corps are currently downsizing. Force size can be cut by decreasing the number of new recruits, allowing early departures, tightening physical and promotion standards, and denying continuation or reenlistment, for instance. But if cuts are not made carefully, the resulting force can have imbalances, and they can persist for years and create future management challenges. Also, when cuts are deep, personnel who have performed well can face involuntary separation, and this could decrease morale and weaken a service's reputation for loyalty to its members. This report develops a drawdown tool, voluntary separation pay, designed to avoid these adverse effects. Voluntary separation pay can achieve a drawdown of a given size in a given period of time and do so at least cost and in a way producing the desired ex post experience mix. In contrast, a policy of involuntary separations can impose direct and indirect costs on service members. Involuntarily separated members could be undercompensated relative to what would be required for voluntary separation, and retained members might perceive a heightened risk of involuntary separation at some future date. This report should interest decisionmakers, analysts, and researchers concerned about military compensation and the retention or separation of military personnel.

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## Summary

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Well-designed voluntary separation pay (VSP) can be used to decrease a military personnel force voluntarily, promptly, and without lingering adverse effects on personnel force structure, such as personnel imbalances by year of service (YOS). The use of VSP requires an initial increase in personnel expenditures but produces net decreases in personnel costs in subsequent years.

### Approach

We extended RAND's dynamic retention model (DRM) to design separation incentives, called VSPs, to decrease Army active component end strength without creating imbalances in experience. The DRM shows how retention changes when pay changes, and it can be used to simulate the effect of separation pays of different amounts and targeted to different years of service, as in a conventional what-if analysis. Going beyond this, we used the DRM to solve directly for the amount of separation pay required to induce a given percentage of service members at a particular YOS to separate voluntarily. We combined the results across YOS cohorts to find a schedule of VSPs that scale down the force to a target level. By keeping the decreases by YOS in scale, it was possible to achieve a smaller force with the same relative experience mix as the original force. The resulting force therefore did not have an experience gap or "bathtub," and it maintained opportunities for promotion and the progression of personnel through the ranks as they accumulated experience. We can adapt the method to reach other experience mixes.

We looked at a variety of drawdown scenarios and, through policy simulation, calculated the VSPs required to achieve the drawdowns, the cost to the Army of implementing the VSPs, the decrease in personnel costs resulting from the departure of personnel, and the experience-profile effects of VSPs over time under each scenario. The scenarios included offering VSPs for one, two, or three years; determining the VSPs needed for an across-the-board cut in force size versus cutting portions of the force more deeply; and determining the effect that announcing VSPs ahead of time had on VSP. The research focused on developing VSP as a drawdown tool, and the report discusses VSP relative to other approaches.

### Key Findings

- VSP can draw down the force rapidly without creating an imbalance in the experience mix of personnel (a bathtub).

- A higher VSP is needed to make a deeper cut in force size, but net personnel cost decreases even so.
- A lower VSP offered for multiple years can achieve the same end-strength goal as a VSP offered for one year, but net decreases in personnel costs are lower because more personnel remain on hand while the VSP is offered.
- If members anticipate being offered VSP, a higher VSP is required to reach a given target.
- A 10-percent cut in the force would produce a net decrease in the present value of active component Army personnel costs of \$6.4 billion to \$7.4 billion in 2013 dollars over the first ten years.
- The cost of implementing VSPs is \$1.7 billion to \$3 billion for a 10-percent cut in the force, depending on whether the VSP is implemented for a window of one, two, or three years and whether the cut is across the board or concentrated on a portion of the force.
- VSPs can be targeted on particular groups, e.g., poorer performers or personnel in over-strength occupations, and thereby induce separations from those groups.

VSPs can draw down the force evenly to a level close to the desired steady-state size and shape (experience mix) within a relatively short period of time, e.g., a year, with no follow-on effects requiring management in later years. Figure S.1 shows the effect of VSPs offered to officers in YOS 7 to 18 combined with an involuntary separation policy for YOS 1 through 6. The VSPs are designed to draw the force down by 10 percent within three years. By the end of three years, the officer population is at or near the steady state for the desired end strength in YOS 1 through 21, and the excess officer population beyond YOS 20 is only 0.9 percent of the original strength. The excess population seems manageable by tighter promotion standards.

Although larger VSPs are required for larger decreases in end strength, a net decrease in personnel costs can still be realized. Even cuts as deep as 40 percent in selected military occupational specialties can produce a net decrease in personnel costs within a few years. This is well within the six-year window of the Future Years Defense Program.

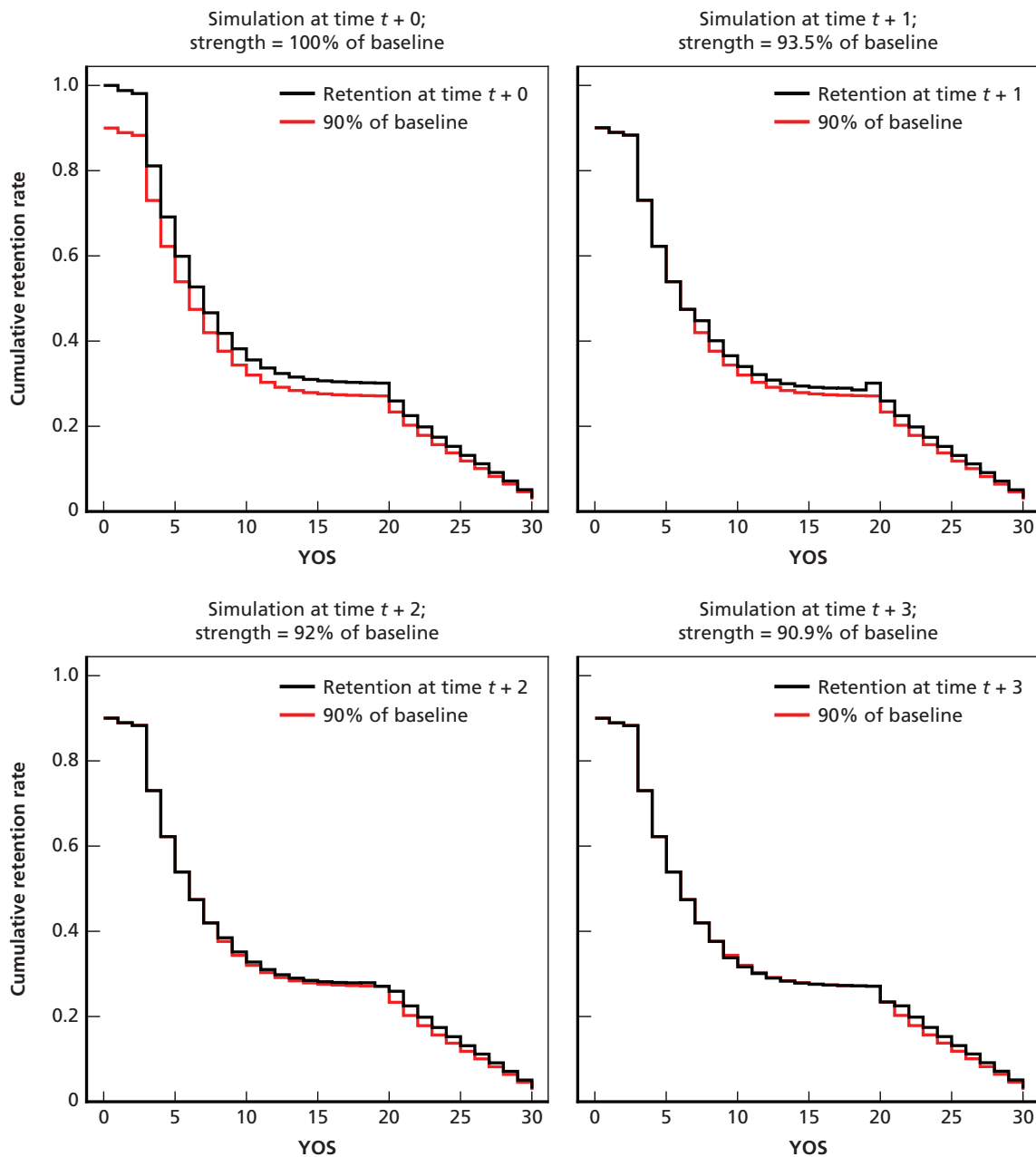
The net decrease in personnel costs is lower if VSP is offered for multiple years. The smaller net decrease in personnel costs occurs because, although the VSP is smaller, personnel leave more gradually, so personnel costs do not decrease as rapidly. However, a more gradual decrease increases the potential for regenerating the force and spreads the cost of implementing the VSP over several years.

The net decrease in personnel costs is also less if members can anticipate that a VSP will be offered. Higher VSPs will be needed because members are more likely to choose to stay in anticipation of the future availability of the VSP. The increase in the required VSP is greater in earlier YOS; members in later YOS are unlikely to leave in any case, and the future availability of a VSP has little effect on their behavior.

The net decrease in personnel costs for Army officers and enlisted personnel is \$6.4 billion to \$7.4 billion in 2013 dollars in the first ten years of scenarios in Table S.1. Each of the scenarios decreases end strength by 10 percent. The first three vary the length of time the VSP is offered from one to two to three years. The other scenarios offer VSP for one year and consider cuts of 10 to 40 percent. In the “draw down all to 90%” scenario, the baseline force is cut by 10 percent, and the other two scenarios are cuts of 20 percent to half the force and 40 percent to one-quarter of the force.

Tables S.2 and S.3 show the initial cost of implementing VSPs in the first year and the decrease in personnel costs (“compensation costs avoided”) in the following years. Depending

**Figure S.1**  
**Army Officer Retention at Baseline and One, Two, and Three Years After Implementation of Voluntary Separation Pay**



RAND RR545-S.1

on how VSP is implemented, the first-year cost varies from \$0.8 billion in Table S.2 to \$3.0 billion in Table S.3. The cumulative decrease in personnel costs soon exceeds these costs.

Involuntarily separated personnel receive involuntary separation pay (ISP). But the roles of ISP and VSP are fundamentally different. ISP is a payment to members that the service selects and involuntarily separates. VSP is a payment to members who self-select and voluntarily choose to separate from the service. The VSP amounts that the DRM computes are for

**Table S.1**  
**Initial Voluntary Separation Pay Cost and the Present Value of the Net Decrease in Personnel Costs for Army Personnel over Five, Ten, and 30 Years, by Scenario, in Billions of 2013 Dollars**

Scenario	Initial Cost of VSPs	Present-Value Net Decrease		
		Over 5 Years	Over 10 Years	Over 30 Years
1-year window	2.0	2.9	7.4	10.7
2-year window	2.6	2.5	7.0	10.3
3-year window	1.7	2.1	6.6	9.9
Draw down all to 90%	2.0	2.9	7.4	10.7
Draw down half to 80%	2.4	2.5	7.0	10.4
Draw down one-quarter to 60%	3.0	1.8	6.4	9.9

NOTE: The change in personnel costs is only for personnel leaving in the years covered by VSPs, YOS 7–18. Discounting is done in accordance with Office of Management and Budget Circular A-94, *Guidelines and Discount Rates for Benefit–Cost Analysis of Federal Programs*, using real discount rates provided in Appendix C of that volume as updated in December 2012.

**Table S.2**  
**Effect of Varying the Participation Window for the Incentive Program: Year-by-Year Voluntary Separation Pay Outlays and Compensation Costs Avoided in the First Ten Years for Army Personnel, in Billions of 2013 Dollars**

Scenario	Budget Element	Year									
		1	2	3	4	5	6	7	8	9	10
1-year window	RMC + NCP savings	—	1.3	1.2	1.2	1.1	1.0	1.0	0.9	0.9	0.8
	Incentive pay cost	-2.0	—	—	—	—	—	—	—	—	—
2-year window	RMC + NCP savings	—	0.7	1.2	1.2	1.1	1.0	1.0	0.9	0.9	0.8
	Incentive pay cost	-1.9	-0.7	—	—	—	—	—	—	—	—
3-year window	RMC + NCP savings	—	0.6	0.9	1.2	1.1	1.0	1.0	0.9	0.9	0.8
	Incentive pay cost	-0.8	-0.6	-0.3	—	—	—	—	—	—	—

NOTE: RMC = regular military compensation. NCP = normal cost percentage. The outlays and costs are only for personnel leaving in the years covered by the VSP, YOS 7–18.

self-selection and voluntary separation and are not intended to indicate the amount of VSP required to cut a given number of people from a population of members designated for *involuntary* separation.

Involuntary separations seem appropriate for relatively small cuts of perhaps 10 percent or less and when criteria are meaningful to the service and perceived as valid by service members. Deeper involuntary separations and less valid criteria, however, could create negative externalities among members, a hidden cost. Also, if involuntary separations are not carefully made, they could create bathtubs. Voluntary separations under VSP provide a balanced experience mix and avoid negative externalities, but they are more costly, especially for deeper cuts, and

**Table S.3**  
**Effect of Varying the Depth of Cuts in a Subset of the Force: Year-by-Year Voluntary Separation Pay Outlays and Compensation Costs Avoided in the First Ten Years for Army Personnel, in Billions of 2013 Dollars**

Scenario	Budget Element	Year									
		1	2	3	4	5	6	7	8	9	10
Draw down all to 90%	RMC + NCP savings	—	1.3	1.2	1.2	1.1	1.0	1.0	0.9	0.9	0.8
	Incentive pay cost	-2.0	—	—	—	—	—	—	—	—	—
Draw down half to 80%	RMC + NCP savings	—	1.3	1.2	1.2	1.1	1.0	1.0	0.9	0.9	0.8
	Incentive pay cost	-2.4	—	—	—	—	—	—	—	—	—
Draw down a quarter to 60%	RMC + NCP savings	—	1.3	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8
	Incentive pay cost	-3.0	—	—	—	—	—	—	—	—	—

NOTE: The outlays and costs are only for personnel leaving in the years covered by the VSP, YOS 7–18.

deprive the service of controlling who separates, apart from setting the criteria to define the eligible population.



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## Abbreviations

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AC	active component
DRM	dynamic retention model
ISP	involuntary separation pay
NCP	normal cost percentage
OMB	Office of Management and Budget
PV	present value
RC	reserve component
RMC	regular military compensation
SSB	special separation bonus
TERA	Temporary Early Retirement Authority
VSI	voluntary separation incentive
VSP	voluntary separation pay
YOS	year of service



## Introduction

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The Office of the Secretary of Defense Cost Assessment and Program Evaluation asked the RAND National Defense Research Institute to devise a monetary incentive for voluntary separations that could be used for military drawdowns, with a particular focus on the Army. The incentive would need to be effective in reaching a given decrease in force size within a given period of time, achieve the desired post-drawdown experience mix of personnel, not cause an outflow of high performers, and be cost-efficient. The voluntary separation pay (VSP) developed in this research meets these objectives.

To design VSP, we made use of the dynamic retention model (DRM) capability developed at RAND in the past decade. The DRM can predict the retention response to a monetary incentive at an individual level and aggregate across individuals to show how the experience mix of retained personnel evolves during and after the drawdown. The DRM has been extensively used to analyze possible changes to special and incentive pays, reserve compensation, and military retirement. Specific challenges in the present research were to find the least-cost VSP for a given drawdown, to consider how the amount of VSP changed when it was to be offered for a single year or multiple years and when it targeted a deeper cut for part of the force versus a shallower cut of the entire force, and to determine whether it was more or less cost-effective when it was announced ahead of time and personnel could anticipate its availability. In addition, the analysis needed to show the cost of implementing the VSP and the personnel costs avoided in subsequent years as personnel left the force.

This document summarizes the issues, methods, simulations, and findings. Chapter Two is a precursor to the analysis and discusses policies that can be used to draw down the force. Chapter Three describes the analytical approach and introduces the DRM, and there is a technical discussion of it in the appendix. Chapter Four describes the results of the analyses, presenting VSPs for enlisted members and officers, by year of service (YOS), for drawdowns of various depths and various approaches to implementation (different window lengths, taking a given cut in force size from the overall force or a portion of it, and announcing the availability of VSP ahead of time, or not). Chapter Four also shows the cost of implementing VSPs for each scenario and the net savings in personnel costs in the following years. Chapter Five summarizes the key findings of the analysis and simulations and discusses voluntary separation with VSP versus the alternative used today, involuntary separation with involuntary separation pay (ISP).



## Policies to Achieve a Drawdown

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Policies to decrease force size include personnel actions and separation incentives. The personnel actions are decreased accessions—the intake of new personnel—of new service members, early separation, denial of continuation or reenlistment, tighter physical standards, and tighter promotion standards. The separation incentives are ISP, voluntary separation incentive (VSI), special separation bonus (SSB), and VSP. VSI and SSB were discontinued in 2001, but we include them for completeness. The personnel policies can be used at the same time. Also, ISP and VSP can be used at the same time. ISP would be paid to members not meeting the physical or promotion standards and therefore not eligible to continue, and VSP would be paid to members eligible to continue yet meeting VSP eligibility criteria. The criteria could aim at lower-performing personnel.

### Decreased Accessions

By decreasing accessions, force size can be decreased over a period of years until a new, lower force size is achieved. This saves costs by decreasing recruiting resources, such as recruiters, recruiting stations, advertising, enlistment bonuses, and educational benefit supplements. But there are limits to the usefulness of this approach in the military. If accessions decrease below the steady-state level for the new, lower force size, there will be a bathtub as these small cohorts move through their military careers. If accessions decrease by less than the steady-state level for the new force size, steps must be taken later to trim these cohorts to size. Further, if only a decrease in accession is used, the experience mix of personnel will be off kilter, with too few junior personnel relative to senior personnel.<sup>1</sup> Finally, to the extent that accessions are decreased, the positions of incumbent personnel are protected. This is advantageous to these personnel but not necessarily advantageous to the service. It must continue pay the personnel costs of incumbent personnel, which is higher than that for new entrants.

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<sup>1</sup> Suppose the active component (AC) enlisted Army had 490,000 soldiers with an average length of stay of seven years and wanted a 10-percent decrease. If the force were in a steady state, it would require  $(490,000 \div 7 =)$  70,000 accessions. A 10-percent decrease would be 49,000 soldiers. In the new steady state, accessions would be 10 percent lower, or 7,000 per year lower, and a cut of 49,000 soldiers would take seven years if done by accessions alone. The drawn-down force would have a junior portion sized for the new, smaller force and a senior portion based on the old, larger force. This would probably be an undesirable experience mix.

## **Early Outs with Voluntary Departure**

Enlisted members and officers can be allowed to leave before completing their terms of service or service obligations. Those choosing to leave early would be those who expected to leave at the end of their obligations. By allowing early departure, the Army can free up spaces that need not be refilled, which is a step in downsizing. The personnel opting to depart do so voluntarily and do not need to be paid to leave. Early outs could be offered in a limited way, e.g., to enlisted members within a year of the end of their first-, second-, or third-term obligations and to officers within a year or 18 months of their active-duty service obligations.

## **Denial of Continuation or Reenlistment**

Under a reduction in force, a member is denied continuation or retention. An analogue is when a company closes a plant and workers are left without jobs (displaced), which, of course, is different from being fired for cause. Reductions in force can be targeted to functional areas, occupations, YOS groups, or lower-performing personnel. A reduction in force need not designate specific individuals for separation but can operate impersonally by setting a departure goal and offering separations on a first-come, first-served basis. This can be expected to attract personnel who value their military careers less than their external opportunities. This could include high-performing personnel—hence the importance of setting criteria that focus exit opportunities on lower performers.

## **Tighter Physical Standards**

Although standards can be tightened somewhat without causing concern, the usefulness of tighter standards depends more generally on the validity of evidence linking the standard to performance on duty. The extent to which a standard would need to be changed depends on the size of the drawdown and the number of personnel near the standard. If many personnel are near the standard, a small change might disqualify enough personnel to reach the target. A small or large change could be viewed as an arbitrary approach to separating personnel if members believe that the standard has low validity, i.e., believe that personnel near the standard perform as well as personnel above the standard. Low validity could be the case in occupations requiring knowledge and experience but having few tasks for which physical strength and endurance are critical. If strength and endurance are critical but many members are well above the standard, a large change in the standard would be needed, again perhaps calling into question its validity. Tighter standards also could induce behavioral changes. Personnel who want to stay in the military but anticipate being ineligible under the tighter standard could improve their physical condition. Those who want to leave could let their condition deteriorate.

## **Tighter Promotion Standards**

For enlisted members, tighter promotion standards take the form of decreasing the allowable time in grade and increasing competitiveness standards. When less time is allowed and com-

petitiveness standards are higher, more service members will be ineligible to continue in service. Officers twice passed over for promotion are ineligible to continue beyond completion of the existing service obligation.

A lower probability of promotion is related to, but different from, tighter promotion standards. When the pool of service members promotable to the next grade is larger than the number of available positions, the probability of ever being promoted to the next grade is lower. This could happen if the service is downsizing, and downsizing could also prompt tighter time-in-grade standards for enlisted members and lower selection probabilities for officers. A service's decision to decrease the number of higher-grade positions is likely to be common knowledge within the service, and members can foresee a slower speed of advancement or lower chance of promotion. This decreases the value of staying in the military and could induce personnel to leave, especially those who feel that their chances of advancement are low. If the promotion system is working to select higher performers for advancement, a decrease in promotion speed and opportunity would be proselective on quality in that lower performers would be more adversely affected and more likely to leave.

### **Involuntary Separation Pay**

U.S. Department of Defense Instruction 1332.29 (Under Secretary of Defense for Personnel and Readiness, 1991 [2011]) states that ISP is “authorized to members of the Regular and Reserve components involuntarily separated” from active duty who meet all of the following conditions: (1) the service member has completed at least six but fewer than 20 years of active service, (b) the separation is “honorable,” and (c) the service member is being involuntarily separated “through either the denial of reenlistment or the denial of continuation on active duty” because of a specific condition, including “promotion or high year of tenure policies” or “reduction in force.”<sup>2</sup> So, if a member exceeds time in grade for promotion, the service no longer has a space for his or her specialty and level, or the member is denied reenlistment or continuation, the member is involuntarily separated and paid ISP. The Department of Defense policy does not identify criteria under which a member can be denied reenlistment or continuation. ISP is a lump-sum payment equal to 10 percent of the annualized value of the member's current monthly basic pay times the number of YOS, including fractions of years—that is,  $0.1 \times 12 \times \text{current monthly basic pay} \times \text{YOS}$ . A member with ten years of service will receive one year's worth of basic pay, for instance.

### **Voluntary Separation Incentive and Special Separation Bonus**

These pays were offered in the 1990s and discontinued in 2001. Temporary Early Retirement Authority (TERA), instituted in the National Defense Authorization Act for Fiscal Year 2012 (Pub. L. 112-81), provided another type of retirement pay that was discontinued in 2002. A 2012–2018 TERA program was created and is expected to end in December 2018.

<sup>2</sup> The instruction also lists other conditions that relate primarily to reserve forces. The two conditions given in the text are the most relevant for our discussion.

VSI was an annuity calculated as 2.5 percent of the member's basic pay times YOS and paid for a period twice as long as the member's active YOS. SSB was a lump sum calculated as 15 percent of the member's annualized monthly basic pay times YOS. The member could choose either VSI or SSB; those with a real personal discount rate of about 20 percent would be indifferent to SSB's lump sum versus VSI's annuity stream. Using the VSI/SSB choice, Warner and Pleeter, 2001, estimated personal discount rates ranging from 0 to 30 percent and where the rate varied with demographic characteristics, education, test scores, and size of payment. According to DRM estimates, the personal discount rate is 10 to 12 percent for enlisted members and 6 percent for officers. At these rates, the VSI annuity would be preferred to the SSB lump sum. Eligibility for VSI or SSB required more than six years and fewer than 20 years of active service. The services offered these pays selectively.

#### The Army

offered VSI/SSB to enlisted members with more than 9 years of service in skills (defined by occupation and grade) that were overfilled. By and large, the main Army eligibility criteria were based on an individual's rank, YOS, and occupation. However, through the judicious choice of these variables, the Army was able to offer the benefit not only to overfilled occupations but also, implicitly, to some marginal performers. (Asch and Warner, 2001, p. 6)

Marginal performance was signaled by a long time in grade or a lower grade than typical for the total YOS. Empirical analysis found that the Army's implementation of VSI and SSB increased exits by 15.7 percent among eligible low-quality personnel and about 11 percent among eligible high-quality personnel. High-quality personnel were high school diploma graduates scoring in the upper half of the Armed Forces Qualification Test score distribution. About 40 percent of the Army personnel in Asch and Warner's data were high quality, and about 60 percent have been high quality in recent years (Hosek, Asch, and Mattock, 2012). At 40 percent high quality, the overall exit rate was 13.8 percent, and 32 percent of VSI- or SSB-induced leavers were high quality.<sup>3</sup> At 60 percent high quality, the overall exit rate would be 12.9 percent, assuming the same respective take rates, and 52 percent of VSI- and SSB-induced leavers would be high quality. The Asch and Warner study does not have comparable results for Army officers.

Beland and College, 1992, uses data on Army and Air Force officer and enlisted personnel to examine whether those who accepted the VSI or SSB offer were lower quality. The authors found that lower-quality personnel generally did accept the offer but that many who accepted would have left in any case. Mehay and Hogan, 1998, studies how separations changed as a result of the VSI and SSB program using data on Navy and Air Force enlisted personnel. The Navy differed from the Air Force in how it implemented the program and, specifically, unlike

<sup>3</sup> Percentage of leavers who were high quality among those who were induced to leave by VSI or SSB is

$$\frac{40 \times 0.11}{60 \times 0.157 + 40 \times 0.11} = 31.8.$$

With an Army of 60 percent high quality, the percentage is

$$\frac{60 \times 0.11}{40 \times 0.157 + 60 \times 0.11} = 51.2.$$



the Navy, the Air Force offer included an explicit threat that anyone who received but did not accept the offer would likely be involuntarily separated. Mehay and Hogan found a modest effect of the VSI and SSB program on Navy separations and, not surprisingly, a larger effect on Air Force separations. As explained in Asch and Warner, the Army policy was somewhere in between the Air Force's policy and the Navy's policy. That is, Army personnel were not explicitly told that anyone who received but did not accept the offer would be involuntarily separated, but personnel might have perceived that such a threat existed.

TERA pay was payable to members with more than 15 but fewer than 20 years of active service. TERA was computed like a retirement benefit: 0.025 times basic pay times YOS. This amount was multiplied by a "reduction factor based on the number of months the retiree is short of 20 years" (Defense Finance and Accounting Service, 2015).

Table 2.1 illustrates ISP, SSB, and VSI amounts for enlisted members and officers at typical grade/YOS combinations. The entries are based on the 2013 basic-pay table. The amount of VSI *to the service member* is shown as the present value (PV) of the annuity stream using personal discount rates of 10 percent for enlisted and 6 percent for officers. The table also shows the cost of VSI *to the government*, which is the amount the government must obligate in the current period to pay the VSI annuity given the cost of capital to the government.<sup>4</sup> Because of the difference between the personal discount rate and the cost of capital to the government, the value of VSI to the member is less than its cost to the government. ISP and SSB are lump sums, and their value to the member equals the cost to the government. ISP is the least generous of the three types of payment, SSB is intermediate, and VSI is the largest. Chapter Five further discusses ISP in comparison with VSP.

## Voluntary Separation Pay

Like ISP, VSI, and SSB, VSP would be paid upon separation. VSP is not calculated from a given formula but determined through modeling and optimization described in this report. VSP is that value of separation pay sufficient to induce the desired number of personnel to leave voluntarily in accord with drawdown objectives. The objectives are to achieve a given decrease in personnel in a given period of time and to leave the resulting force as close to steady state as possible, avoiding management issues caused by over- or underdrawing the force. VSP is offered between seven and 18 YOS,<sup>5</sup> and its amount varies by YOS. VSP can be targeted, e.g., by rank, occupation, YOS, time in grade, and average speed of promotion (rank relative to YOS).

Unlike ISP, VSI, and SSB, VSP is designed to separate personnel voluntarily. ISP is a payment to personnel separated involuntarily; ISP does not need to be high enough to induce voluntary separation. We find that, in larger drawdowns, ISP is insufficient compensation for the

<sup>4</sup> We use the average real government interest rate for 2004–2013 for a 20-year maturity Treasury bond, which is 2.54 percent (Office of Management and Budget [OMB], 1992).

<sup>5</sup> Early- and late-career personnel qualify for other benefits when they separate. Early-career personnel are often eligible for Post-9/11 GI Bill (Title V of Pub. L. 110-252, 2008) educational benefits. Also, some early leavers have discovered that they are not a good fit with the military and would prefer to leave. Late in their careers, members with 20 or more YOS qualify for immediate retirement benefits and health benefits. These benefits are substantial and compensate for much of the loss from serving somewhat fewer years than expected. Overall, these other benefits seem likely to address concern about "breaking faith" for these groups.

**Table 2.1**  
**Illustrative Amounts of Involuntary Separation Pay,**  
**Voluntary Separation Incentive, and Special Separation**  
**Bonus, in Thousands of 2013 Dollars, Rounded**

Grade	YOS	ISP	SSB	VSI	
				Value to Member	Cost to Government
Enlisted					
E-5	8	26	39	54	82
E-5	10	35	52	80	133
E-5	12	44	66	107	194
E-6	14	59	88	149	292
E-6	16	68	102	178	372
E-7	18	90	135	238	530
Officer					
O-3	8	51	77	132	163
O-3	10	68	101	200	259
O-4	12	94	141	306	416
O-4	14	115	173	403	572
O-4	16	136	204	502	741
O-5	18	171	256	655	1,006

loss of one's military career (Chapter Five). Further, VSI or SSB might be too small or too large to meet a specific drawdown goal; their formulaic approach, like that of ISP, is not designed to meet a specific goal.

VSP is more generous than ISP, and implementing it can be expected to cost more. However, ISP and the involuntary separation policies that accompany it might create negative externalities, e.g., off-budget costs, such as lower morale or higher effort to manage the personnel force structure that can result from involuntary mechanisms, inadequate levels of compensation, or separation pay levels that are incorrect with respect to achieving a given drawdown.

## An Overview of the Approach

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The DRM is well suited to the analysis of incentive pays. Recent applications of the model include analyses for the ninth, tenth, and 11th Quadrennial Reviews of Military Compensation; analyses of special and incentive pays for the Air Force; and analyses of military retirement reform proposals. Model capability has steadily increased with faster estimation and simulation programs and refined costing, and the model now can predict retention and cost effects in the steady state and transition to the steady state.

The DRM is a stochastic dynamic programming model of individual decisionmaking over the life cycle. The model's parameters are estimated using individual, longitudinal retention data from administrative data files. Starting at the beginning of AC service, the individual makes a stay/leave decision each year. Those who leave the AC take a civilian job and simultaneously decide whether to participate in the reserve component (RC). The decision of whether to participate in the RC is made each year, and the person can move into or out of the RC period by period. Interestingly, including reserve participation improves the precision of the empirical estimates of parameters governing active retention.<sup>1</sup>

The approach is documented in RAND reports, such as Mattock, Hosek, and Asch, 2012, a technical report prepared for the 11th quadrennial review; and Asch, Hosek, and Mattock, 2013, a report prepared for the Office of the Assistant Secretary of Defense for Manpower and Reserve Affairs. This work was further extended to consider the effect that policy changes can have on force size and shape over time during the transition to a new steady state in Asch, Mattock, and Hosek, 2013.<sup>2</sup> The appendix has a technical description of the model.

The present study extends the DRM to include a routine to find the optimal amount of separation pay to induce members in a particular cohort—that is, members at a particular YOS at the time of policy implementation—to separate voluntarily from the military to meet an end-strength goal for that cohort in a given period of time. This technique finds separation incentive pays that decrease any YOS cohorts by an arbitrary amount and bring the force overall to a size and shape that supports the new desired steady state. It can scale the force overall or scale selected occupations to maintain the experience profile while decreasing the strength to a desired level.

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<sup>1</sup> The DRM has several limitations. The model assumes that military pay, promotion policy, and civilian pay are time-stationary, and it excludes demographic factors, such as gender, marital status, and spouse employment. It also excludes health status and health care benefits, and we do not explicitly model deployment or deployment-related pay. That said, the estimated models fit the observed data well for the both the AC and the RC.

<sup>2</sup> Goldberg, 2001, provides an extensive discussion of the history of retention models. Gotz, 1990, provides a detailed discussion of the advantages of the DRM approach relative to other approaches that have been used to assess the effects that compensation proposals can have on retention.

In the optimization routine, we want the new force to be near its steady state as soon as possible and want to avoid over- or undershooting the decrease of a cohort relative to its steady state. Overshooting would cause a shortage relative to the steady state, and the shortage would move through the force over time. Further, if the drawdown is not balanced by YOS and some cohorts are not decreased to a steady-state level, the experience mix could not be in steady state for many years.

The DRM is a behaviorally rich model of retention, its estimated parameters are statistically significant, and its predicted retention fits the data well. It is theoretically and empirically well grounded for determining the level of separation pay needed to meet drawdown targets without over- or undershooting the outflow of personnel. The DRM employs certain assumptions. Individuals are assumed to be forward-looking and able to assess the value of remaining in the AC for another year, which, in turn, depends on the value of remaining in the year after that and so on. Individuals can assess the value of leaving the AC to work as a civilian and participate in the RC, or not. Individuals make rational choices, which means that they select the best alternative given the information available to them each period. If there were changes to the structure of decisionmaking (e.g., changes not present in the retention data used to estimate the model), the model's predictions might not be good forecasts of future behavior if the separation incentive were implemented. If the model's specifications were inadequate (e.g., if it should have included additional variables), the predictions could be inaccurate. However, the model fits the data well. Finally, if an optimized VSP were implemented, there could be other conditions that affect retention. The model's predictions are a starting point for setting VSP, but actual implementation calls for flexibility to adjust VSP in view of prevailing conditions. This point also applies to implementing other drawdown approaches.

To describe our approach, consider VSP offered for one year only and not anticipated. We reasoned that, for a drawdown of  $x$  percent, a new force would be in a steady state if each drawn-down cohort had  $x$  percent fewer members at 19 YOS. For each cohort, we asked what amount of VSP would result in the cohort having  $x$  percent fewer members at YOS 19. We focus on 19 YOS because the distribution of taste for military service differs across the cohorts in the military as a result of selective retention; members with higher taste for military service are more likely to remain in service, and our research has shown mean taste to increase as YOS increase.<sup>3</sup> As a result, if we decreased cohorts by  $x$  percent at their YOS at policy implementation, cumulative retention to YOS 19 would differ by cohort, and the drawn-down force would not be in steady state. By comparison, using YOS 19 as the basis for computations controlled for differences in taste by cohort. Also, YOS 19 is the year before a member vests in the military retirement system. AC members with 20 YOS can retire with an immediate annuity. These benefits are themselves a form of separation pay that induces members to leave.

Our approach provides the same, steady-state cumulative retention as of YOS 19 for each current cohort being decreased in size by VSP. Also, although the steady-state level is not reached in the year VSP is offered, the retention decrease for each cohort in that year comes

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<sup>3</sup> In the model, *taste* refers to a member-specific fixed effect, that is, a term that is constant over time. The model allows taste to differ from member to member, and estimation of the model identifies the taste distribution across members, i.e., the mean and variance of taste for active duty, the mean and variance of taste for duty in a service's RCs, and the correlation between active and reserve tastes. An individual's taste for service in an AC, for example, is the combined, net effect of the individual's preference for service, value placed on the amenities and disamenities of serving, and any persistent, unobserved differences between the individual's expected military earnings and earnings if a civilian (e.g., earning differences not captured in the average military and civilian pay lines used in estimating the model).

close to the steady-state decrease. That is, almost all of the decrease to the new steady state is obtained in the calendar year VSP is offered. The small remaining percentage is obtained by YOS 19. As a result, most of the cost savings occur right away, and the small difference from steady state in that year is justified by the objective of avoiding future imbalance. The imbalance would occur because, although a cut to steady-state level in the year VSP is offered would at first look optimal, retention in future years of those retained would differ from steady-state retention because of taste differences. Again, we eliminate these imbalances by computing a cohort's retention to YOS 19 and then working backward to find the VSP needed to generate the same cumulative retention to YOS 19 across all the drawn-down cohorts.

We considered multiyear windows for the drawdown, e.g., when members had two or three years to decide whether to accept VSP. A given percentage reduction at 19 YOS remained the goal, and we modified the individual's value of leaving the AC in the DRM to make the separation incentive payment available for a second or third year. As will be shown, VSP can be less when the window is wider. Intuitively, the chance that a given incentive will be acceptable is higher for two "draws" than one, so the same chance can be maintained by a lesser amount. Yet, because this allows individuals to strategically delay their departure, retention and personnel costs decrease more slowly.

Another aspect of policy design was whether to make an early announcement of the VSP policy. If the policy is announced a year or two before implementation, members can anticipate it. We find that leads to an increase in retention prior to implementation, which, in turn, requires higher VSP to achieve the same goal.



## Results

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An objective of our analysis was to develop a separation incentive whereby a service could draw down the force without creating a bathtub. We demonstrate that, by using a combination of targeted VSP in YOS 7 through 18 and involuntary separations in YOS 0 through 6, we can scale Army strength to 90 percent of current strength while preserving the experience profile of the force. This scaling down can be done in one to three years, depending on the service's preference.

We explore alternatives for reaching 90 percent of current end strength via cutting portions of the force more deeply than others. We obtain estimates of the higher VSP required for these deeper cuts. Despite the higher amount of VSP, we also find that a net decrease in personnel costs can still be realized.

We then examine the effect of offering VSP for multiple years and find that a lower VSP offered for two or three years can achieve the same end-strength goal as a VSP offered for one year. The reduction in VSP required can be fairly large. However, even though offering VSP for multiple years reduces the expenditure on separation pays, the net decrease in the personnel budget is lower because personnel leave the force more gradually, and compensation and retirement accrual charges must be paid until they leave.

We look at the possible impact of foreknowledge of a VSP being offered some time in the future. We find that, if members anticipate being offered VSP, a higher VSP will be required to reach a given end-strength goal. This is due to members who might otherwise leave choosing instead to stay until they can collect VSP and leave.

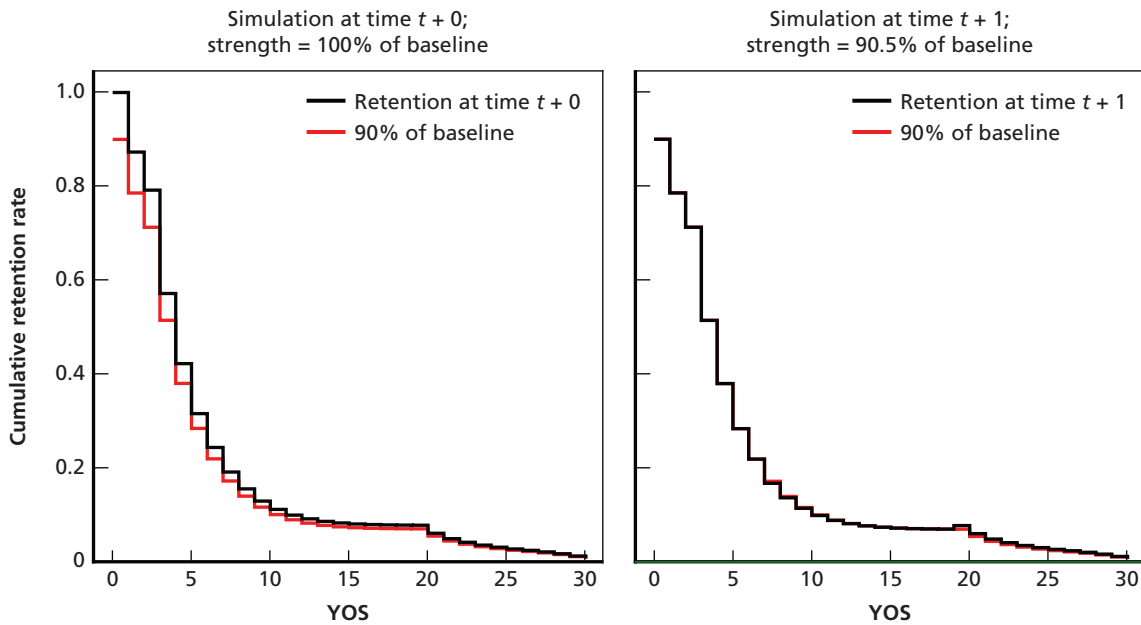
Finally, we evaluate the impact that a VSP has on Army personnel budget costs under various scenarios. We find that the decrease in budget costs can be significant, with a net decrease ranging from \$6.4 billion to \$7.4 billion over the first ten years. The initial expenditure for VSP is not trivial, so a service would at first require additional resources to implement VSP.

### Using Incentives to Draw Down the Force

#### Targeted Incentives Can Draw Down Enlisted Occupations Rapidly

Figure 4.1 illustrates a 10-percent drawdown—the new force is 90 percent of the baseline force size—in the YOS targeted for VSP, YOS 7 through 18. Here, we assume a one-year window of opportunity. For each cohort, the model optimized the amount of VSP to achieve a 10-percent decrease in each cohort's projected size as of YOS 19. This amount differs by cohort, i.e., by YOS at the time of policy implementation. The left panel of Figure 4.1 shows Army enlisted strength by YOS at baseline (black line), where the number of personnel in year 0 is normalized

**Figure 4.1**  
**Army Enlisted Retention at Baseline and One Year After Voluntary Separation Pay Implementation**



RAND RR545-4.1

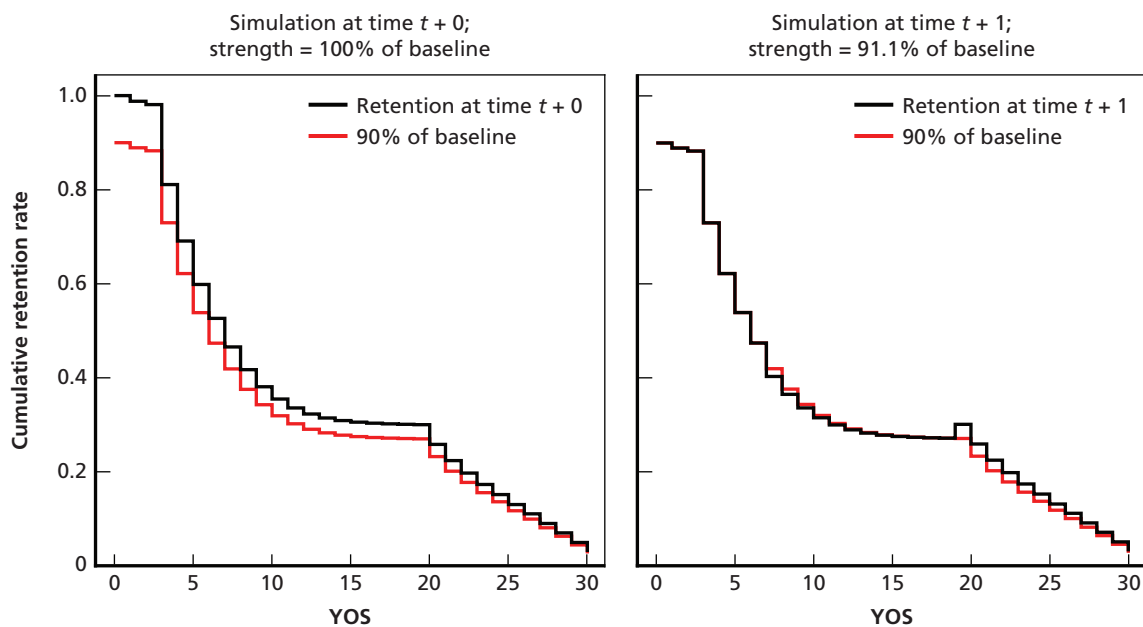
to 1; *year 0* refers to the year the VSP policy is implemented. The red line shows the desired enlisted force size. We call this force the target force, which here is a force size of 90 percent of baseline. The right panel shows the force size achieved one year after the implementation of VSP. The panel's title indicates that the force size is 90.5 percent of baseline—the full draw-down is nearly complete after only one year. Further, the decrease is balanced by YOS. This is mechanical in YOS 0 through 6 because we assume that nonmonetary means are fully effective in drawing down the front-end force within a year. Also, in YOS 19 and higher, there has been no decrease; here, we assume that most incumbent personnel will retire within a few years and little is lost by waiting for the reduced, pre-19 YOS cohorts to arrive. The key interest is in YOS 7 through 18, and, as seen, the decreased force is already quite near the target force after one year. VSP has succeeded in covering nearly all the distance between the current force and the target force in the space of one year. The balanced nature of the decrease in size implies that the decreased force is already near its steady state. By construction of the optimized VSP amount, each drawn-down cohort will be at 90 percent of its size by YOS 19. So in this case, the VSP appears to undershoot the target in the first years. The decrease is to 90.5 percent of force size rather than the full decrease to 90 percent.

#### **Voluntary Separation Pay Also Can Rapidly Draw Down Officer Occupations**

The same explanation applies to officers, and the main finding remains that VSP results in a force that is close to the target force even after one year (Figure 4.2). But, in this case, the right panel has visible discrepancies at YOS 7, 8, and 9 between the baseline force one year after implementation of VSP and the target force. A close look back at the right panel of Figure 4.1 reveals similar differences, though they are hard to see. These differences result from the approach we have chosen. The amount of VSP resulting in a 10-percent-smaller cohort



**Figure 4.2**  
**Army Officer Retention at Baseline and One Year After Voluntary Separation Pay Implementation**



RAND RR545-4.2

when the cohort reaches YOS 19 causes *more* than a 10-percent decrease in the cohorts at YOS 7, 8, and 9. This is necessary to be in the steady state as of YOS 19; if fewer personnel were separated at, say, YOS 7, the taste for military service among the remaining personnel would have been too high and the number of personnel reaching YOS 19 would have been more than the target of 90 percent of baseline. This is not an arbitrary statement but is a consequence of the estimated taste distribution and the process of selective retention that the DRM captures.

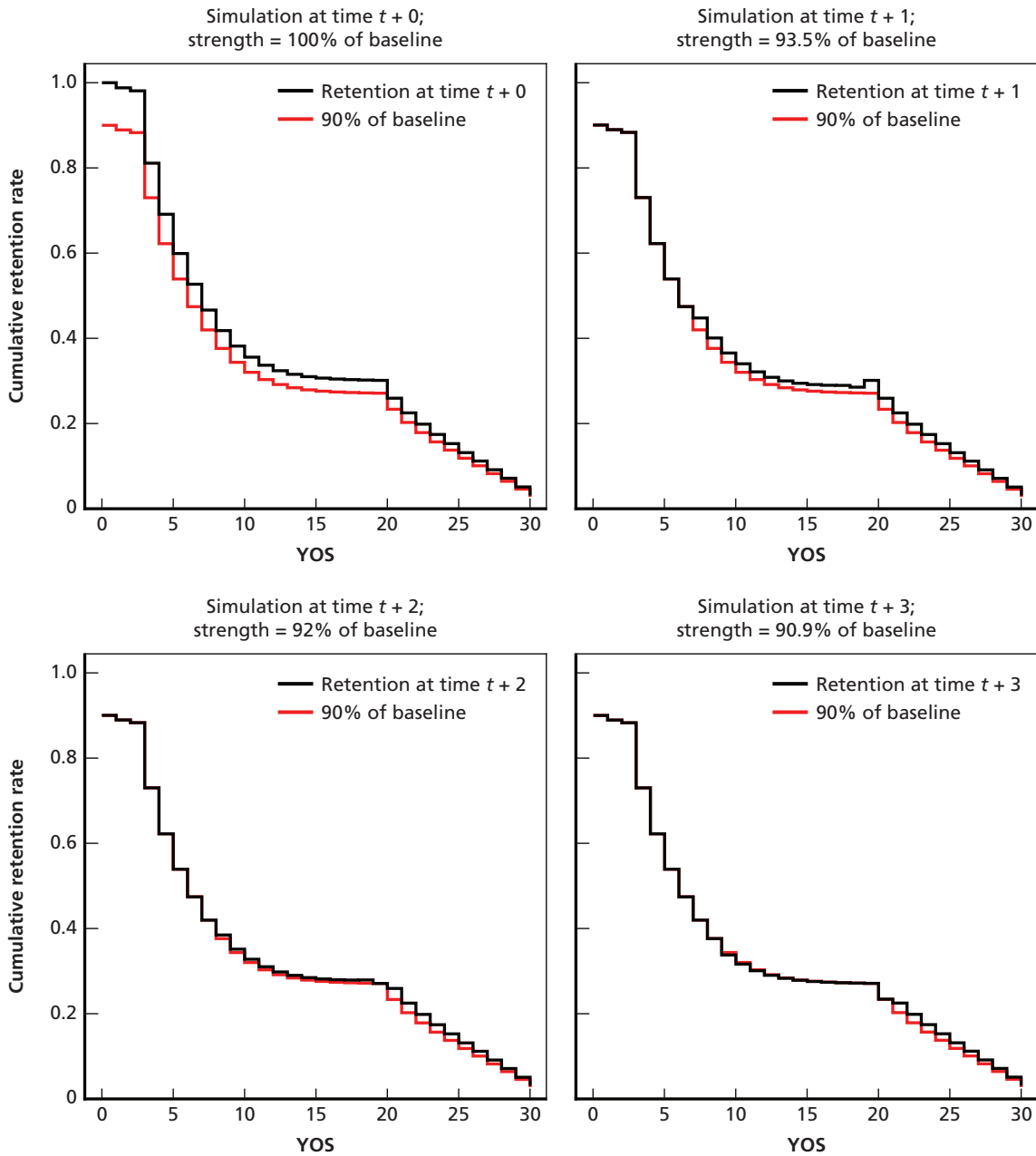
VSP is offered in YOS 7 through 18, so, in the right panel of Figure 4.2, it is not surprising to see that, at YOS 19 and higher, the force has *not* been drawn down (the black line has not moved). The Army could wait for the “extra” officers to leave voluntarily through routine retirement decisions or take actions to speed departures. It could decrease the number of spaces available for senior, high-rank positions. This would decrease an officer’s likelihood of promotion and decrease the value of staying. Officers who perceived themselves to be marginal for promotion would now be more likely to leave. The Army could offer early outs so officers who intended to leave could do so without completing their obligations. The Army might institute a temporary transition bonus as a financial incentive to leave.

#### **Voluntary Separation Pay over Multiple Years Can Draw Down the Force More Gradually**

A given-size drawdown can be achieved gradually by offering VSP for more than one year. The panels in Figure 4.3 depict the Army officer force when VSP is offered for three years. The force size is 93.5 percent of baseline one year after implementation, 92 percent after two years, and 90.9 percent after three years.

In some instances, a more gradual drawdown is in the service’s interest. If military operations were ending but another contingency arose, a gradual drawdown could make it easier to regenerate the force. Also, service members might appreciate a gradual drawdown when the

**Figure 4.3**  
**Army Officer Retention at Baseline and One, Two, and Three Years After Voluntary Separation Pay Implementation**



RAND RR545-4.3

civilian labor market is weak, in which case having the option to delay departure would be helpful. A separation incentive available for two or three years provides a long period to search for a civilian job offer.

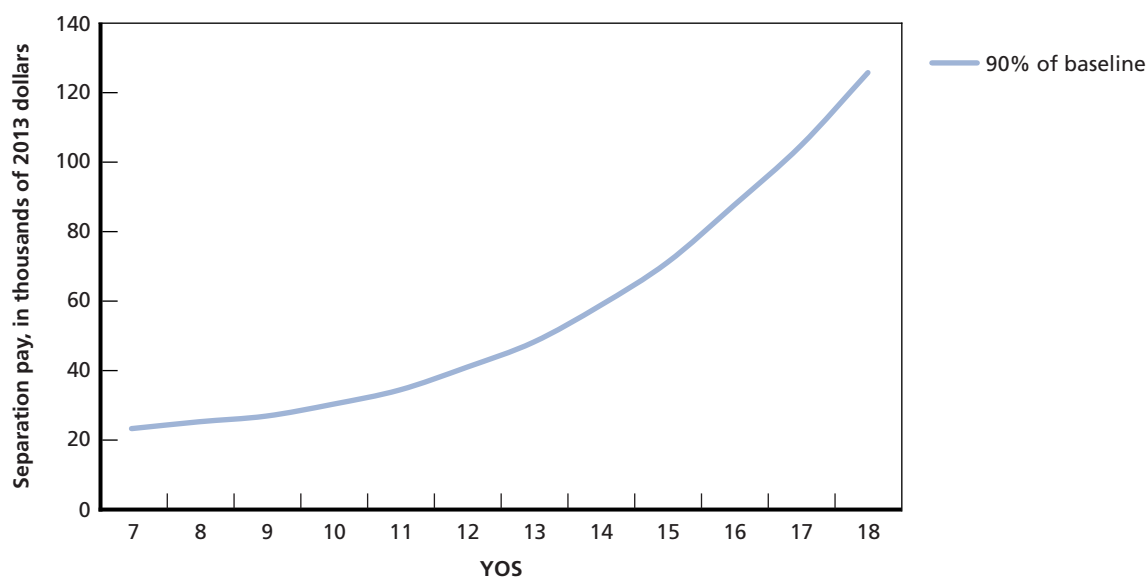
## How Large Do Voluntary Separation Pays Need to Be to Induce People to Leave Voluntarily?

The VSP necessary for a voluntary 10-percent decrease in force strength in YOS 7 through 18 increases from about \$22,000 at YOS 7 to \$40,000 at YOS 12 to \$130,000 at YOS 18 (Figure 4.4). The rapid increase from YOS 12 to 18 reflects the increasing influence of expected military retirement benefits on the value of staying in service. The present discounted value of expected future retirement benefits increases rapidly because the probability of reaching 20 YOS and qualifying for retirement benefits increases with YOS, and the stream of benefits is discounted for fewer years.

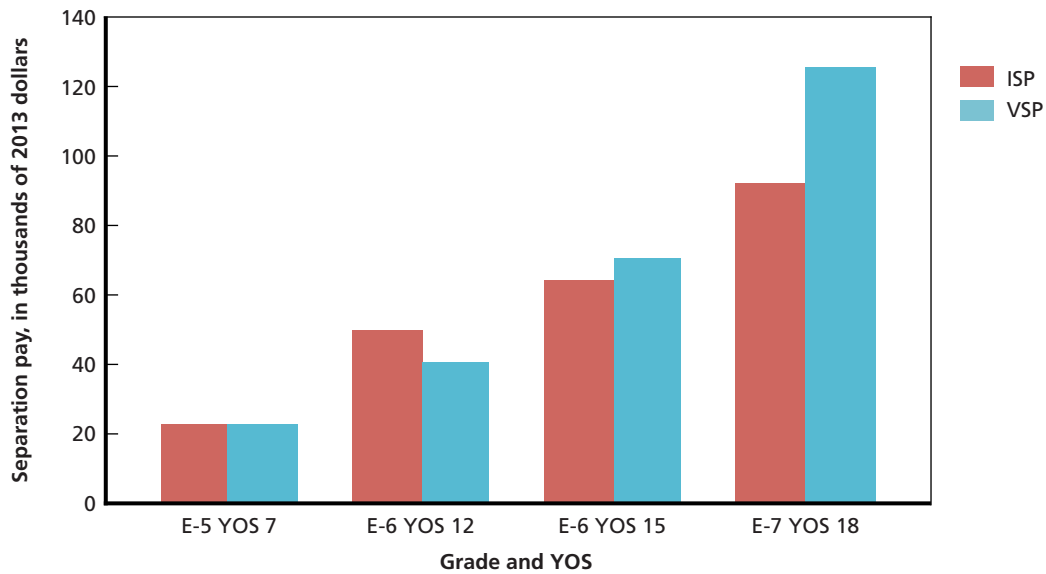
The value of VSP can be compared with that of ISP. In 2013, ISP was \$22,743 for an E-5 with seven YOS, \$50,332 for an E-6 with 12 YOS, \$64,000 for an E-6 with 15 YOS, and \$92,470 for an E-7 with 18 YOS. The respective VSPs in Figure 4.4 are \$23,000, \$41,000, \$71,000, and \$126,000. Thus, for a drawdown of 10 percent or less, ISP and VSP are equal at seven YOS, ISP is \$9,000 higher than VSP at 12 YOS, \$7,000 lower at 15 YOS, and \$34,000 lower at 18 YOS. (See Figure 4.5.) Thus, for deeper drawdowns, personnel who would have voluntarily separated under VSP would be undercompensated if involuntarily separated under ISP.

But this is not a strict comparison. ISP is typically targeted by criteria, such as rank, YOS, and occupation, and these criteria can directly or indirectly focus on lower-quality soldiers. Although VSP can be targeted the same way, the VSP amounts in Figure 4.4 are for across-the-force cuts in the given YOS range. A closer comparison would be if VSPs were estimated for the target groups. Stated differently, a service can select those to be involuntarily separated, while members self-select under a program of voluntary separation. The VSP needed to induce members selected for involuntary separation to separate voluntarily might be less or greater than the

**Figure 4.4**  
Required Voluntary Separation Pay at Each Year of Service to Meet 90 Percent of Baseline Retention at Year of Service 19 in an Enlisted Occupation



**Figure 4.5**  
**Involuntary Separation Pay Compared with Required Voluntary Separation Pay to Meet 90 Percent of Baseline Retention at Year of Service 19 in an Enlisted Occupation**



RAND RR545-4.5

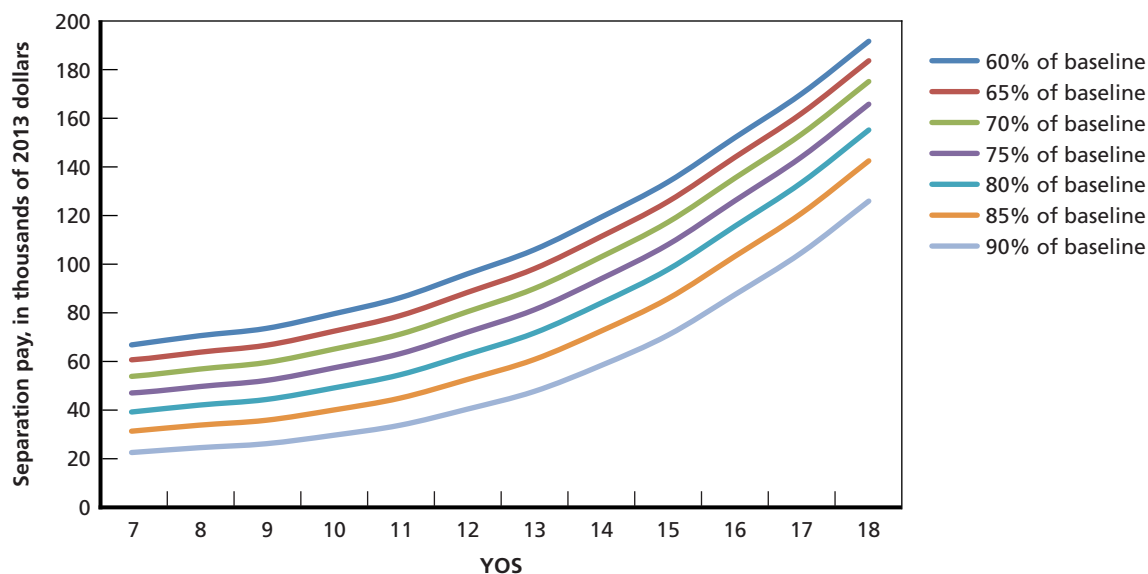
VSP for self-selects. The VSP amount would be greater, for instance, if members' preferences for military service were higher or their civilian job opportunities were poorer. At the same time, those selected for involuntary separation would presumably be of low value to the service, and the service might not want to spend more than required under ISP to separate them. This suggests different roles for VSP and ISP depending on the nature of the drawdown. VSP seems suited to an across-the-board drawdown of well-performing members who are in excess supply, and ISP seems appropriate for a drawdown focused on low performers.

The amount of separation incentive pay at a given YOS increases with the depth of the drawdown (Figure 4.6). Deeper cuts separate members with higher preferences for military service, and they require more compensation to offset their higher preferences. If the 10-percent cut were implemented by a 20-percent cut targeted to half the force, the VSPs for the cases above would be \$34,000, \$63,000, \$98,000, and \$155,000, all of which are larger than the VSPs for a 10-percent cut targeted to the entire force.

#### **Higher Voluntary Separation Pay Is Needed to Reach Lower Enlisted End-Strength Goals**

By implication, as the depth of the drawdown increases the number of members who would voluntarily separate if offered VSP but who were instead involuntarily separated, the ISP they would receive would be increasingly less than the amount they would consider fair payment for the early end of their military careers. This is because ISP is determined by a formula depending only on pay grade, YOS, and officer/enlisted status. It does not consider the worth of a military career to the individual, whereas VSP does.

**Figure 4.6**  
**Required Separation Pay at Each Year of Service to Meet a Set Percentage of Baseline Retention at Year of Service 19 in an Enlisted Occupation**



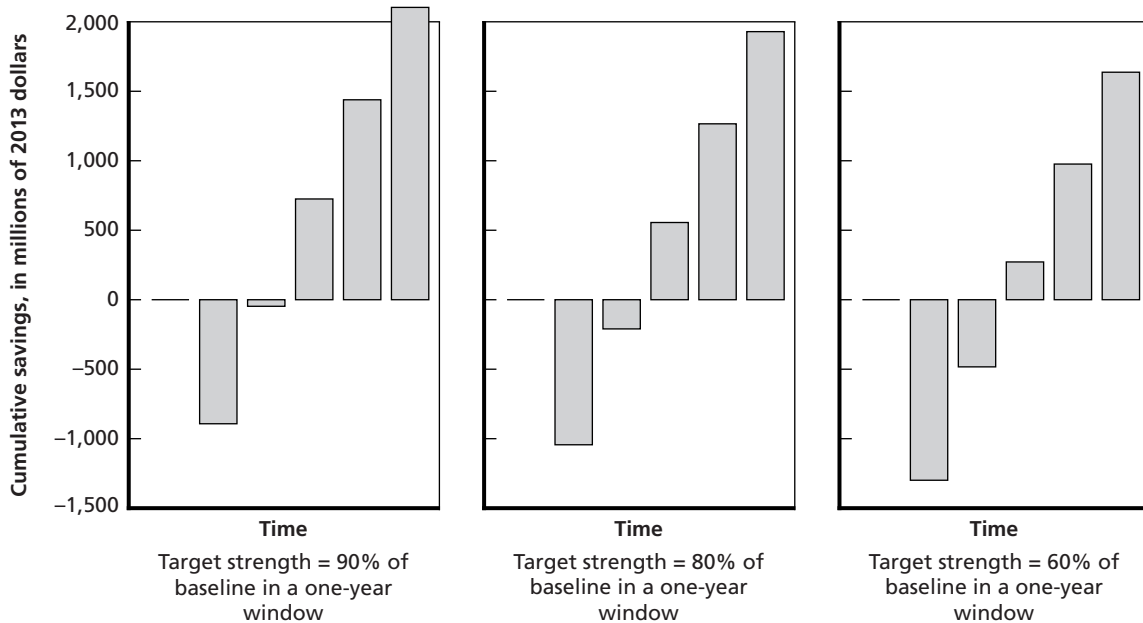
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### Personnel Costs Still Decrease If Selected Enlisted Military Occupational Specialties Are Cut Deeply

Drawdowns can involve some force restructuring, so cuts might be smaller for some occupation or experience groups and larger for others. The more narrowly focused a drawdown of a given absolute size—a given number of soldiers—the higher the VSP required. This reflects the nature of voluntary response, along with differences among individuals in the value they place on their military careers. Those volunteering to leave are self-selected, and the first ones to volunteer are those placing lower values on their military careers than on outside opportunities. Prior to the VSP, the values of their military careers were high enough to keep them in the military, but VSP tips the scales toward leaving. A drawdown of 40 percent of one-fourth of the force will require a higher VSP than a drawdown of 10 percent of the total force. Generally, the VSP must be set high enough to induce the member at the margin of the drawdown to leave, and, because each member's value of staying is private knowledge, the same VSP must be offered to all.

Figure 4.7 shows three drawdowns, each separating a given number of personnel using an unanticipated, one-year VSP. The panels show the undiscounted, cumulative *decrease* in personnel costs over the first five years after policy implementation. In the first year, the bar in the figure is negative, indicating a cost increase; these are the outlays required to implement the VSP. The bars in years 3, 4, and 5 are positive, indicating a *cumulative* decrease in cost. Because of VSP-induced separation, fewer personnel remain in the force, and personnel costs are lower. The left panel is for a 10-percent cut over the whole enlisted force, the center panel is for a 20-percent cut to half the force, and the right panel is for a 40-percent cut to one-quarter of the force.

**Figure 4.7**  
**Undiscounted Cumulative Change in Personnel Costs in the First Five Years of Using Voluntary Separation Pay to Decrease the Army Enlisted Force by 10 Percent, Half by 20 Percent, or One-Quarter by 40 Percent**



NOTE: The change in personnel costs is only for personnel leaving in the years covered by the VSP, YOS 7–18.

RAND RR545-4.7

In each case, the VSP policy requires an increase in outlays in the first year and generates a decrease in cumulative personnel costs by the third year. Further, the decrease in personnel costs is less the more narrowly focused the drawdown. One year after implementation, personnel costs are negative because of outlays of nearly \$1 billion for the whole force, about \$1.1 billion when drawing down from half the force, and about \$1.3 billion when drawing down from one-quarter of the force. The cumulative change in personnel costs remains negative two years after implementation; the personnel costs avoided in the second year are not enough to offset the outlays in the first year. By year 3, there is a cumulative cost decrease. This occurs not only because most of the drawdown was accomplished in the first year, as discussed above, but also because there have now been two years with a lower pay bill because of the decreased force size. Lower costs continue to cumulate through year 5. Cumulative personnel costs are about \$2 billion lower when the drawdown is across the board, \$1.8 billion lower when focused on half the force, and \$1.6 billion lower when focused on one-quarter of the force.

#### **Officers Require Higher Separation Incentives Than Enlisted Members Do**

As a step toward estimating the change in personnel costs for officers, we first present estimates of officer VSPs required to meet a given drawdown goal. Current compensation for officers is roughly twice as high as for enlisted members, and officers are more than twice as likely to qualify for retirement benefits. For these reasons, we expect officer VSPs to be higher than those for enlisted members. Recall that enlisted VSPs for a 10-percent drawdown were about \$22,000 at year 7, \$41,000 at year 12, \$71,000 at year 15, and \$126,000 at year 18. Compa-

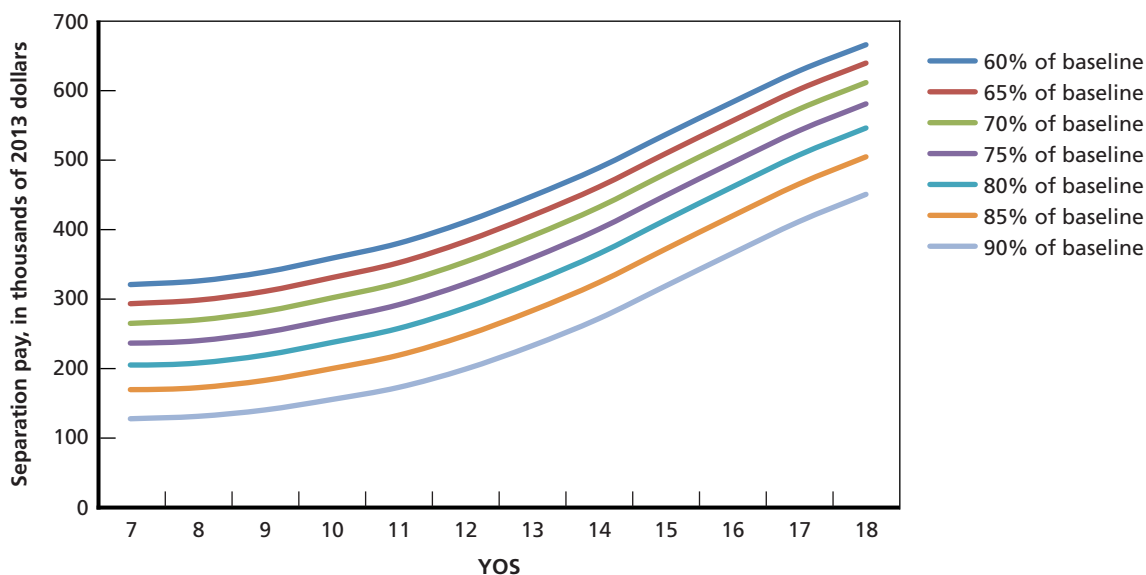
able VSPs for officers are \$128,000, \$200,000, \$320,000, and \$452,000 (Figure 4.8). Also, as with enlisted members, deeper drawdowns require higher VSPs.

By comparison, ISP amounts in 2013 for selected cases were as follows: \$45,037 for an O-3 with seven YOS, \$98,682 for an O-4 with 12 YOS, and \$157,328 for an O-4 with 18 YOS. These amounts are far below the VSPs for a 10-percent drawdown, which suggests that ISPs would be viewed as inadequate compensation for involuntary separation of the personnel who would have accepted VSP. Again, we bear in mind that this population is self-selected and could differ from the officers whom a service would choose for involuntary separation. When drawdowns are higher than 10 percent, ISPs are even less adequate.

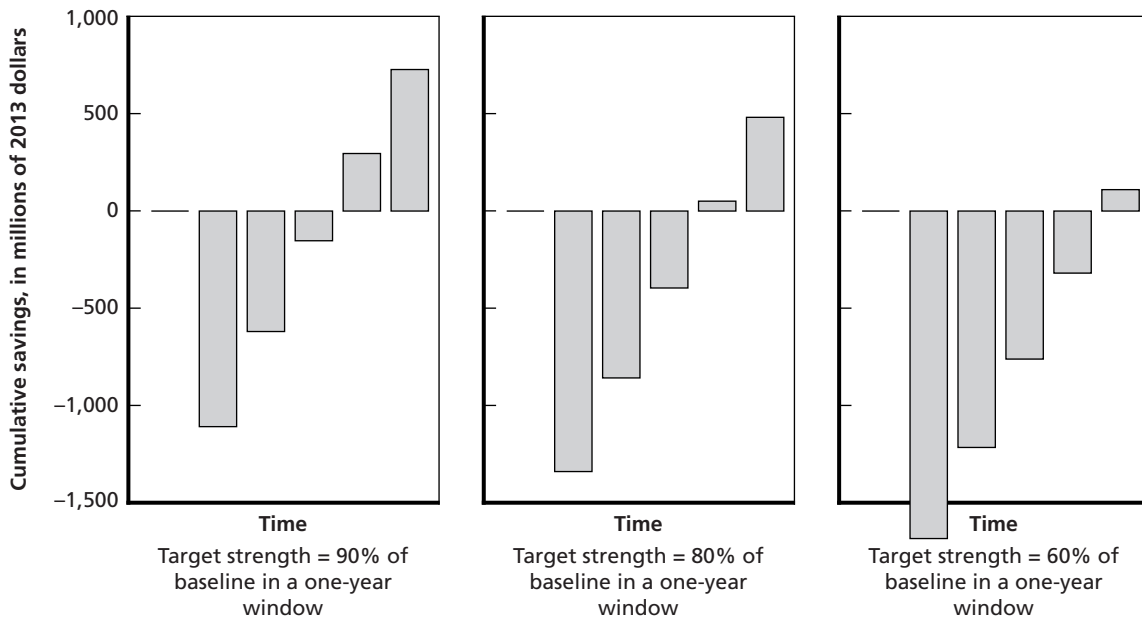
### Although Officers Cost More to Separate, a Net Decrease in Personnel Costs Can Still Be Realized

Using VSP to draw down the officer force by a given percentage requires higher initial outlays than for the same-percentage drawdown of the enlisted force. This is because VSPs are higher for officers. Still, cumulative officer personnel costs are lower within three to five years. Figure 4.9 shows the cumulative decrease in personnel costs over the first five years after an unanticipated, one-year VSP to decrease the officer force by 10 percent. As before, the amount and time pattern of the cumulative cost decrease depends on whether the officer decrease comes from the whole force, half the force, or one-quarter of the force. A deeper, more narrowly focused drawdown requires a higher VSP. Here, the initial cost is highest when the drawdown separates 40 percent of one-quarter of the force versus 20 percent of half the force, although equal numbers of officers are separated.

**Figure 4.8**  
Required Voluntary Separation Pay at Each Year of Service to Meet a Set Percentage of Baseline Retention at Year of Service 19 in an Officer Occupation



**Figure 4.9**  
**Undiscounted Cumulative Personnel Cost Decrease in the First Five Years of Using Voluntary Separation Pays to Decrease the Whole Army Officer Force by 10 Percent, Half by 20 Percent, or One-Quarter by 40 Percent**



NOTE: The change in personnel costs is only for personnel leaving in the years covered by the VSP, YOS 7 through 18.

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### Cost Change Under Broader and Narrower Drawdowns of a Given Size

Table 4.1 has cost information for Army officers and enlisted personnel over a ten-year span. Figures 4.7 and 4.9 show the cumulative decrease in personnel costs, while Table 4.1 shows the cost change from baseline by year (not cumulatively). The costs are for a drawdown of 10 percent in YOS 7 through 18 in which the VSP is not announced ahead of time and is offered for one year. The three scenarios are to decrease the entire force by 10 percent, decrease half the force by 20 percent, and decrease one-fourth of the force by 40 percent.

The cost of VSPs, made in year 1 only, are \$2 billion when applied to the entire force, \$2.4 billion applied to half of the force, and \$3 billion applied to one-fourth of the force. Separating 40 percent of one-fourth of the force costs half again as much as separating 10 percent of the whole force, \$3 billion versus \$2 billion. Deeper cuts reach soldiers who place a higher value on their military careers, and a higher VSP is required to induce the soldier at the margin to separate voluntarily. The higher VSP is paid to all voluntarily separating soldiers, and the cost of VSPs is therefore higher.

The VSP cost and decrease in personnel costs (costs avoided) in Table 4.1 are for members in the YOS range in which VSPs are offered, YOS 7 through 18. The Army would realize additional decreases in personnel costs from the decrease in personnel in years 0 through 7, which, as discussed, are done in the first year by nonpecuniary means. As the table shows, personnel



**Table 4.1**  
**Effect of Varying the Depth of Cuts in a Subset of the Force: Year-by-Year Separation Pay Outlays and Compensation Costs Avoided in First Ten Years, for Officer and Enlisted Personnel Together**

Scenario	Budget Element	Year									
		1	2	3	4	5	6	7	8	9	10
Draw down all to 90%	RMC + NCP savings	—	1.3	1.2	1.2	1.1	1.0	1.0	0.9	0.9	0.8
	VSP cost	-2.0	—	—	—	—	—	—	—	—	—
Draw down half to 80%	RMC + NCP savings	—	1.3	1.2	1.2	1.1	1.0	1.0	0.9	0.9	0.8
	VSP cost	-2.4	—	—	—	—	—	—	—	—	—
Draw down a quarter to 60%	RMC + NCP savings	—	1.3	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8
	VSP cost	-3.0	—	—	—	—	—	—	—	—	—

NOTE: RMC = regular military compensation. All figures are in billions of 2013 dollars and are not discounted to a given year, such as year 1. The change in personnel costs is only for personnel leaving in the years covered by the VSP, YOS 7 through 18.

costs are lower throughout the period from two to ten years after the VSP is offered. The cost decrease comes from cost avoidance: Having fewer personnel means a lower pay bill.<sup>1</sup>

Personnel cost decreases begin at \$1.3 billion in year 2 under all three scenarios and are \$1.1 billion to \$1.3 billion in years 3 and 4. Starting in year 5, the decreases continue through year 10, getting progressively smaller, but are still \$0.8 billion in year 10.

## Voluntary Separation Pay Can Be Smaller If Members Are Given More Time

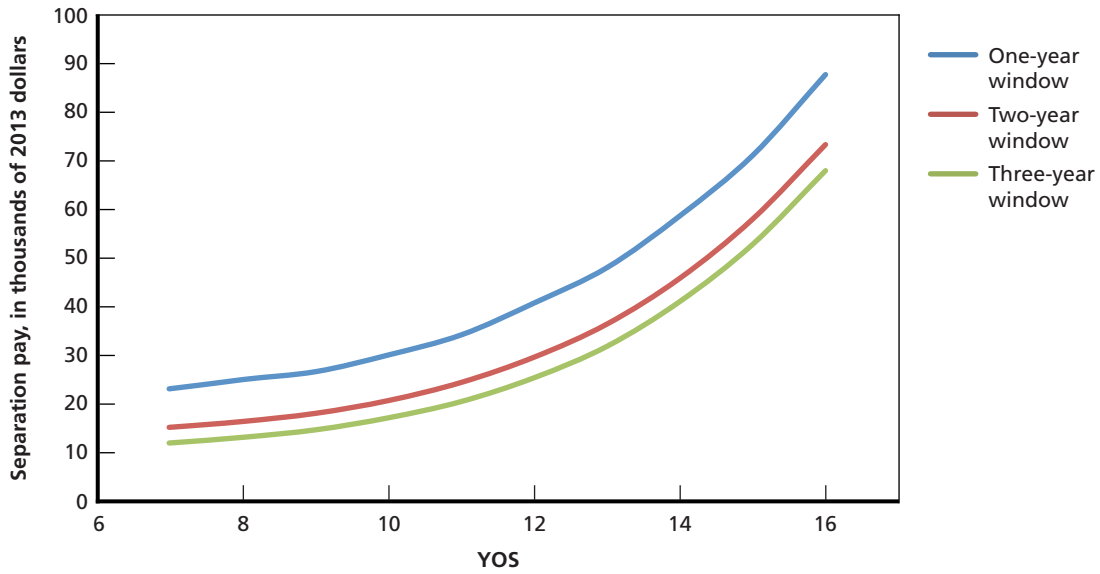
In formulating a VSP policy, one dimension is how long to offer the incentive. We illustrate the sensitivity of the VSP amount to the length of the window by YOS and for enlisted and officers, for VSPs designed to reach a given drawdown target of 90 percent of the baseline force and for windows of one, two, or three years. We then show the cumulative decrease in personnel costs over the first five years after policy implementation for each window, and we show VSP cost and personnel cost decreases over ten years for each window. We end this chapter with evidence of the robustness of the finding that the VSP is lower when the window is longer.

### A Lower Voluntary Separation Pay Offered for a Longer Time Can Achieve the Same Target

Figures 4.10 and 4.11 show VSP by YOS for different-length windows for enlisted members and officers, respectively. As seen, the VSP at any given YOS decreases with the length of the window. The decrease is greater when going from a one-year window to a two-year window than from a two-year to a three-year window.

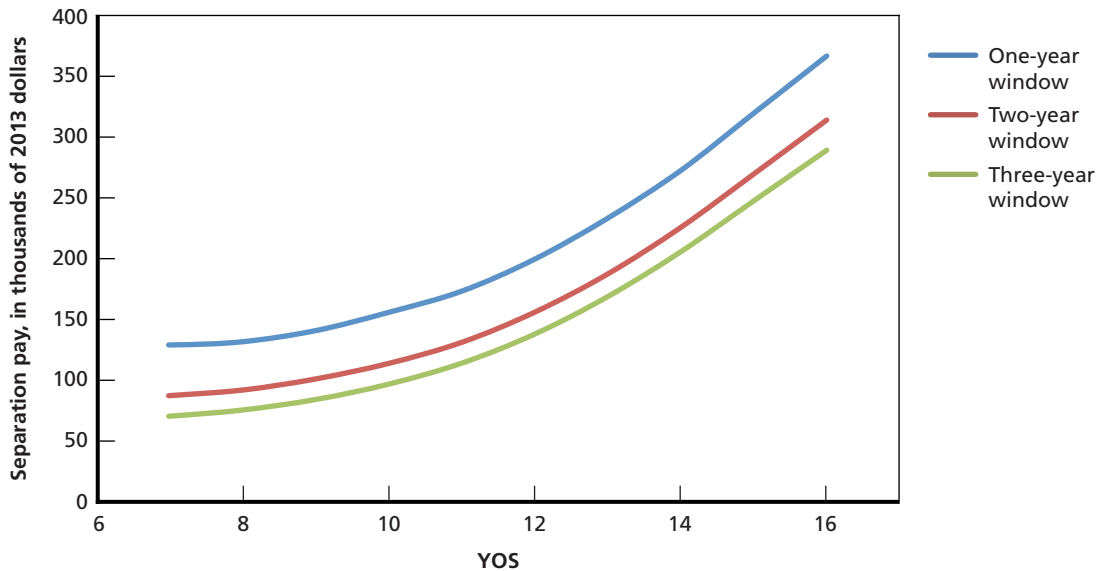
<sup>1</sup> In particular, there are decreases in the bill for RMC and the retirement accrual charge. RMC here is the sum of basic pay, basic allowance for subsistence, and basic allowance for housing. RMC usually also accounts for the allowances not being subject to federal income tax, but that is not part of the service's personnel budget and so is excluded here. The accrual charge equals the NCP times the expenditure for basic pay. We use an NCP of 43.3 percent that includes costs to the Army—which accounts for more than three-quarters of the accrual cost—and to the Treasury.

**Figure 4.10**  
**Required Voluntary Separation Pay to Reach 90 Percent of Baseline, by Window of Availability, Army Enlisted**



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**Figure 4.11**  
**Required Voluntary Separation Pay to Reach 90 Percent of Baseline, by Window of Availability, Army Officers**



RAND RR545-4.11

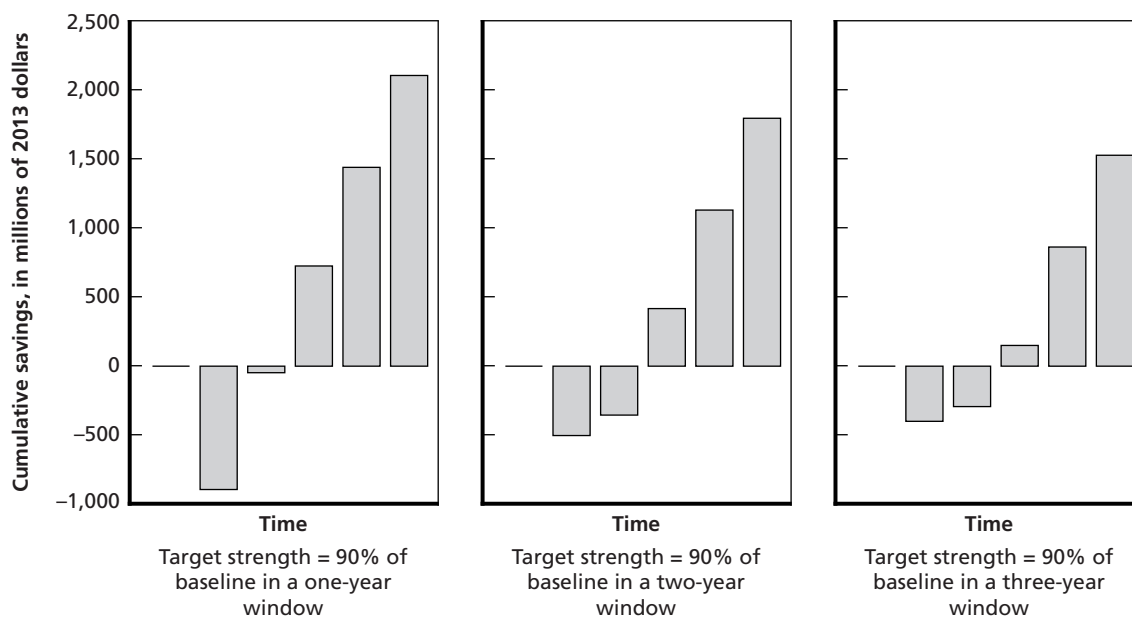
The decrease in VSP is consistent with the idea that the member on the margin of the drawdown target is willing to accept less if the window is two or three years instead of one because the probability of finding an acceptable external offer is higher over a longer window.

If VSP were kept at its value for the one-year window but the window were extended to two or three years, the VSP would be too generous, and more than 10 percent of personnel would leave. To prevent this, VSP is decreased as shown. The smaller decrease from a two-year to a three-year window than from a one-year to a two-year window reflects the smaller incremental gain in the probability of finding an acceptable external offer. The actual computation is more complex than a comparison of probabilities, however, because the value functions for staying and leaving change from one YOS to the next, and the computation takes this into account.

### A Longer Window Decreases Volunteer Separation Pay Cost but Also Decreases the Decrease in Personnel Costs

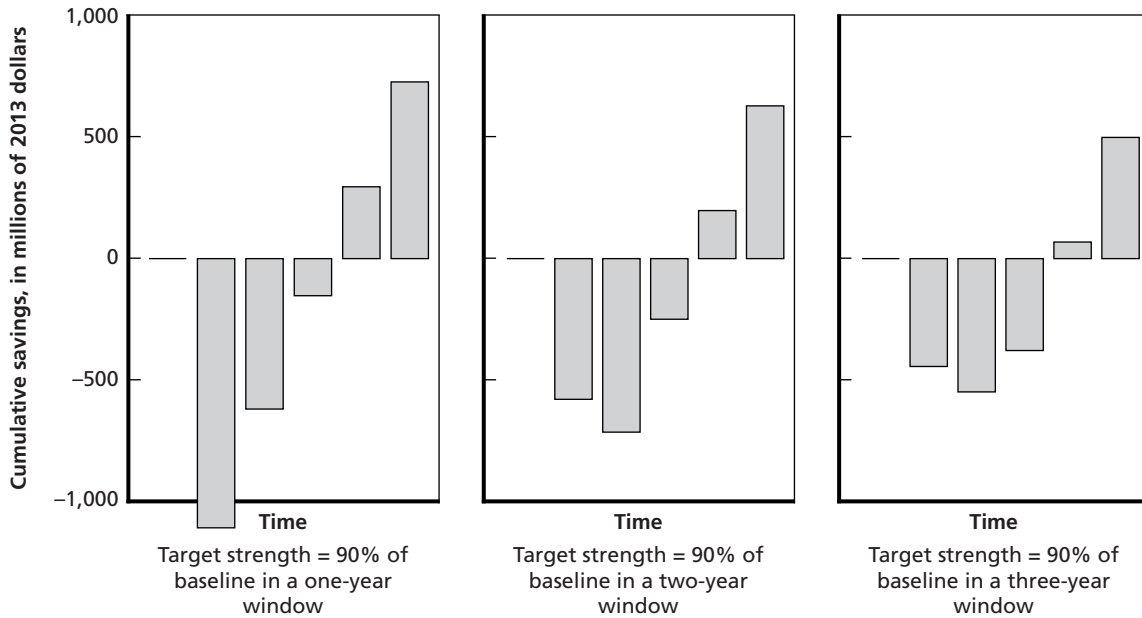
A variety of factors affect the choice of window length. Longer windows are beneficial if the service wants a more gradual drawdown or wants to give members affected by the drawdown more time to find a civilian job. Lengthening the window decreases the VSP amount required to reach a drawdown goal (Figures 4.10 and 4.11) and decreases the current-year budget cost of the VSP as well. But a longer window leads to less decrease in personnel costs (Figures 4.12 and 4.13)—more personnel remain on board longer and must be paid. For example, the year 1 cost of VSP for a 10-percent drawdown is about \$900 million for the Army enlisted force for a one-year window and \$400 million for a three-year window. The cumulative cost decrease at year 5 is about \$2.1 billion for the one-year window and \$1.5 billion for the three-year window. The results for officers parallel these figures. Year 1 cost is \$1.2 billion for a one-year window and \$400 million for a three-year window, while year 5 cumulative decrease in personnel costs is \$750 million and \$400 million, respectively.

**Figure 4.12**  
Undiscounted Cumulative Decrease in Personnel Costs in the First Five Years of Reducing the Army Enlisted Force by 10 Percent over One, Two, or Three Years



NOTE: The change in personnel costs is only for personnel leaving in the years covered by the VSP, YOS 7 through 18.

**Figure 4.13**  
**Cumulative Decrease in Personnel Costs from Reducing the Army Officer Force by 10 Percent over One, Two, or Three Years**



NOTE: The change in personnel costs is only for personnel leaving in the years covered by the VSP, YOS 7 through 18.

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Table 4.2 shows VSP costs and the decrease in personnel costs over ten years for the one-, two-, and three-year windows. Like those in Table 4.1, the cost decreases in Table 4.2 are limited to members induced to leave by the VSPs, and cost decreases are from the RMC and retirement accrual costs avoided by their separation relative to what the costs would have been.

**Table 4.2**  
**Effect of Varying the Participation Window for the Voluntary Separation Pay Program: Year-by-Year Separation Pay Outlays and Compensation Costs Avoided in First Ten Years, for Officer and Enlisted Personnel Together**

Scenario	Budget Element	Year									
		1	2	3	4	5	6	7	8	9	10
1-year window	RMC + NCP savings	—	1.3	1.2	1.2	1.1	1.0	1.0	0.9	0.9	0.8
	Incentive pay cost	-2.0	—	—	—	—	—	—	—	—	—
2-year window	RMC + NCP savings	—	0.7	1.2	1.2	1.1	1.0	1.0	0.9	0.9	0.8
	Incentive pay cost	-1.9	-0.7	—	—	—	—	—	—	—	—
3-year window	RMC + NCP savings	—	0.6	0.9	1.2	1.1	1.0	1.0	0.9	0.9	0.8
	Incentive pay cost	-0.8	-0.6	-0.3	—	—	—	—	—	—	—

NOTE: All figures are in billions of 2013 dollars and are not discounted to a given year, such as year 1. The change in personnel costs is only for personnel leaving in the years covered by the VSP, YOS 7 through 18.

The VSP costs are incurred in years 1 and 2 for the two-year window and in years 1, 2, and 3 for the three-year window. Much of this cost occurs in the first year, however. The personnel cost decreases occur between years 2 and 10 and are lower in the first few years for the longer windows but nearly equal across the windows from year 4 onward.

### **The Effect of a Longer Window of Availability Is Consistent Across Target Retention Levels**

For a 10-percent drawdown, the VSP is less for a two-year window than for a one-year window, and still less for a three-year window. This finding generalizes to drawdowns ranging up to 40 percent (Figures 4.14 and 4.15 for enlisted and officers).

The figures show the VSP by YOS required to reach a given drawdown target for a one-year window (upper panel) and a two-year window (lower panel). For either window, a deeper drawdown requires a higher separation incentive. Given the drawdown target, the VSP is lower for the two-year window than for the one-year window. Decreasing the officer force to 80 percent of baseline requires a VSP at 12 YOS of about \$290,000 for a one-year window and \$240,000 for a two-year window, for example. The numbers for enlisted personnel are about \$60,000 and \$50,000, respectively.

### **A Higher Voluntary Separation Pay Is Required When the Voluntary Separation Pay Policy Is Announced Ahead of Time**

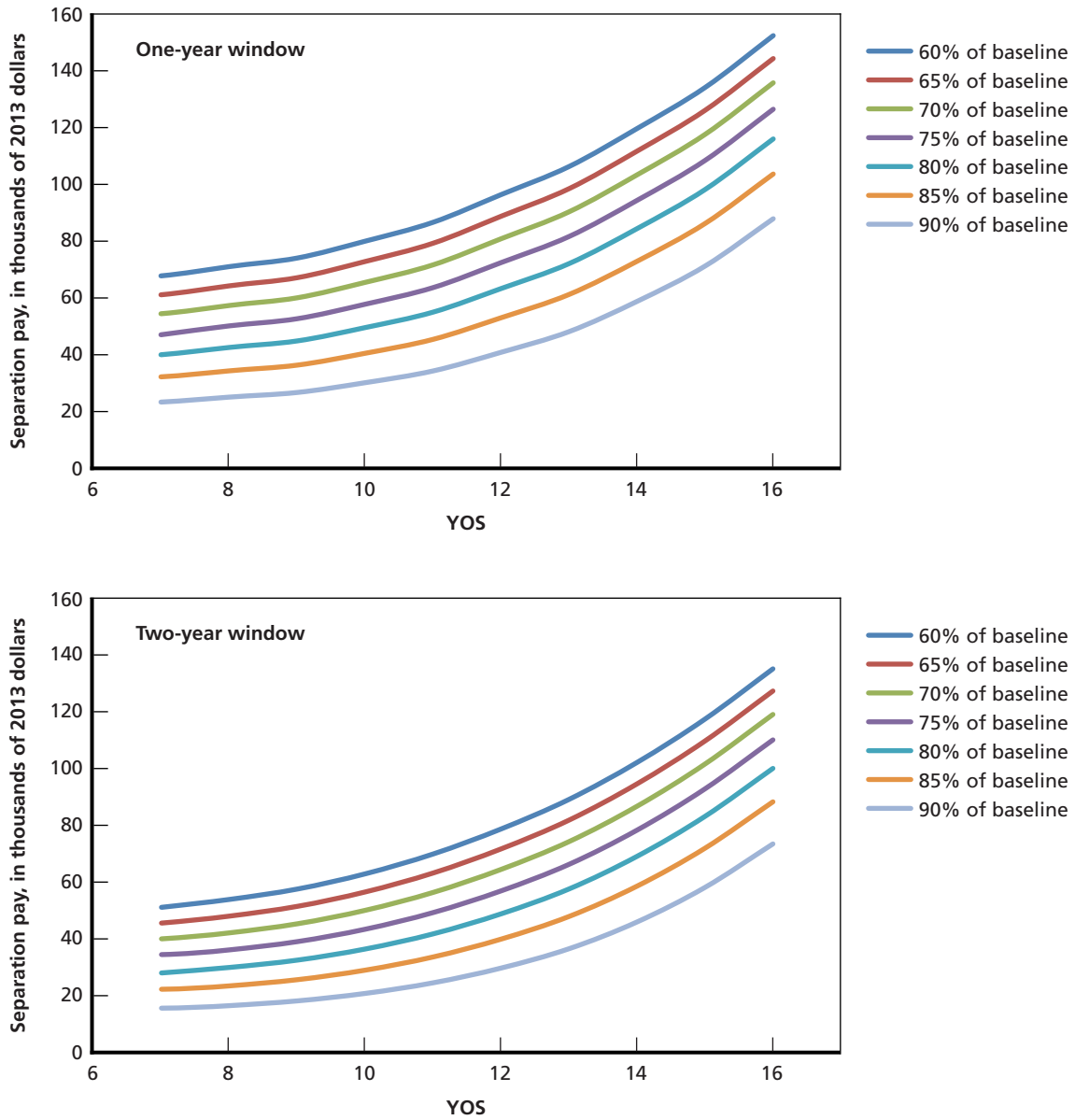
When a VSP policy is announced ahead of time, the VSP must be higher the earlier the announcement (Figures 4.16 and 4.17). The increase is greater at lower YOS and almost negligible at YOS 17 and 18. The increase occurs because a VSP to be offered several years hence increases the gain from staying in service, which increases retention. With more personnel being retained, the incentive needed for a given drawdown target is higher. This increase in retention probably could be limited by tighter physical and promotion standards, though Figures 4.16 and 4.17 show the impact on VSP without such controls. The increase in VSP is larger at lower YOS for two reasons: retention is more responsive at lower YOS than at higher years—that is, the anticipation effect is greater at lower years; and with higher retention, a higher separation incentive is needed to reach the drawdown target.<sup>2</sup>

### **The Required Increase in the Voluntary Separation Pay Diminishes with Years of Service**

The percentage increase in VSP is lower at higher YOS. Figures 4.18 and 4.19 show both the percentage increase and the dollar increase in VSP if it is anticipated by one or two years. At high YOS, VSP is already high when there is no prior announcement, i.e., no anticipation. This is because members generally expect to qualify for retirement benefits, so VSP must be large to induce them to leave voluntarily. More-senior personnel with greater YOS have a high taste for the military on average and a high retention rate, and knowing ahead of time about the sepa-

<sup>2</sup> The announcement that a VSP will be available in a year (or two) increases the value of staying in the AC in the current year, which, in turn, increases retention. The incremental retention response with respect to an increase in the value of staying has the following form in the dynamic retention model:  $\Pr(A)(1 - \Pr(A))$ . This takes its highest value of 0.25 when  $\Pr(A) = 0.5$ , which is roughly the empirically observed value in early-career YOS. At high, pre-20 YOS,  $\Pr(A) = 0.95$  or so, and the retention response is only 0.0475.

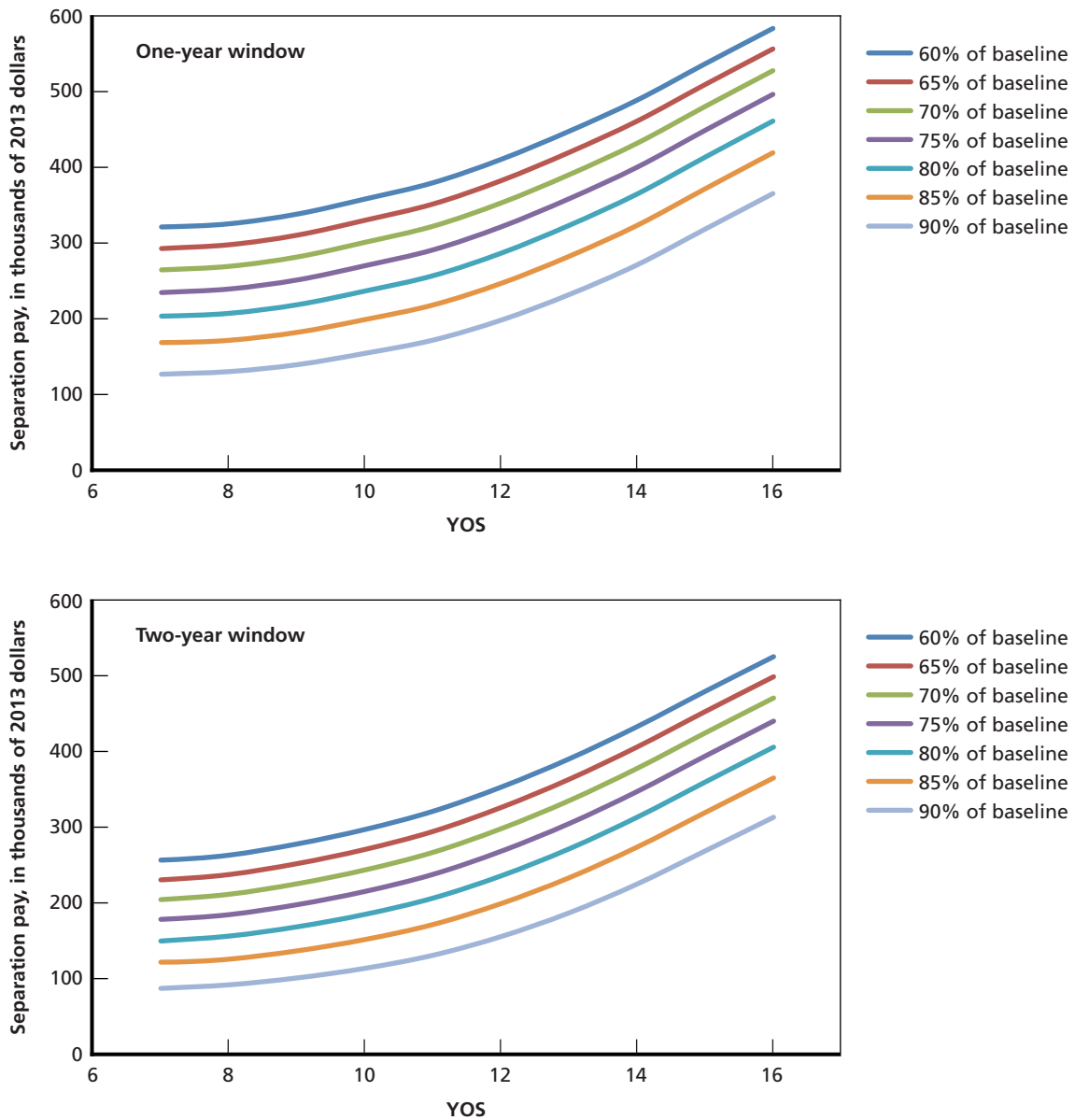
**Figure 4.14**  
**The Effect of a Longer Window of Voluntary Separation Pay Availability Is Consistent Across Target Retention Levels, Army Enlisted**



RAND RR545-4.14

ration incentive does little to change their retention behavior. As a result, both the percentage change and the dollar increase in VSP are smaller at high YOS.

**Figure 4.15**  
**The Effect of a Longer Window of Voluntary Separation Pay Availability Is Consistent Across Target Retention Levels, Army Officers**

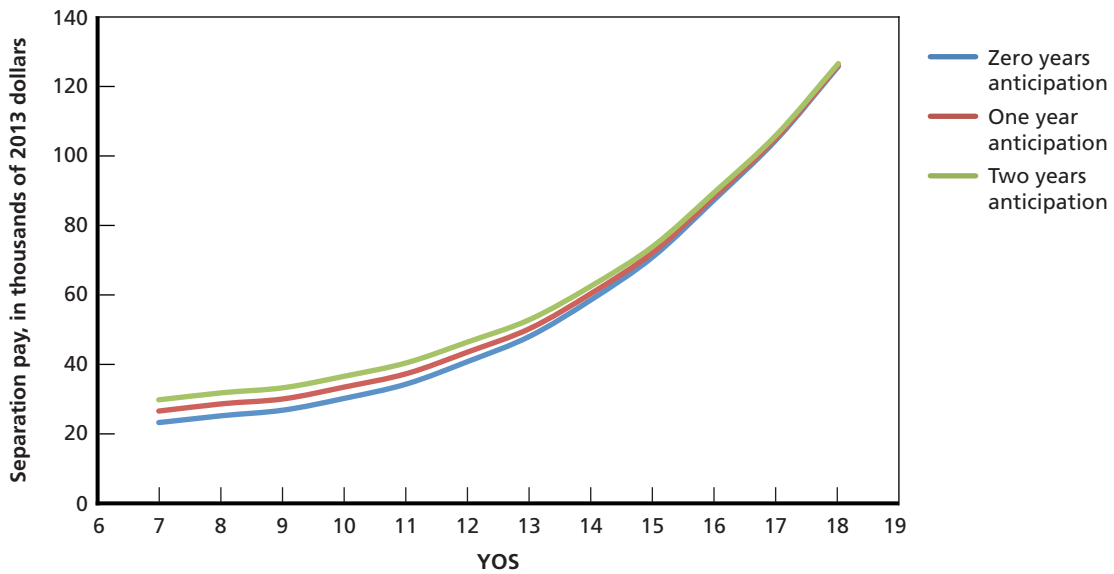


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### Present Value of the Decrease in Net Personnel Costs Under Different Alternatives

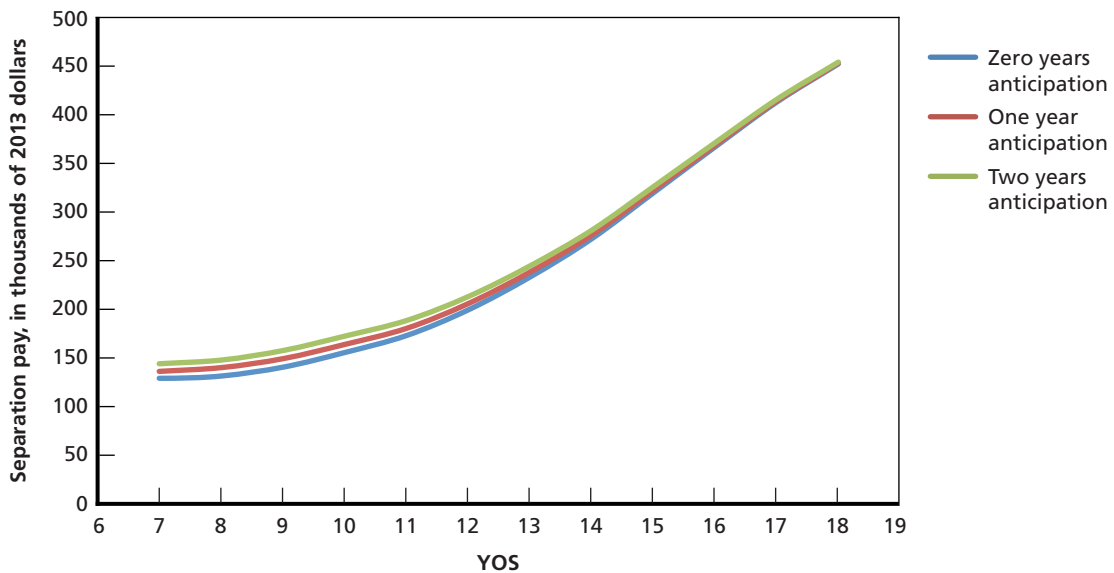
Table 4.3 draws together the cost decreases over horizons of five, ten, and 30 years for the scenarios involving different window lengths and for broadly versus narrowly targeted drawdowns with a 10-percent cut in the force. The cost decreases are given as PVs in which the discounting has been done according to OMB guidance as of December 2012. In each case, VSP is

**Figure 4.16**  
**Required Voluntary Separation Pay to Reach 90 Percent of Baseline If Anticipated by Zero, One, or Two Years, Enlisted**



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**Figure 4.17**  
**Required Voluntary Separation Pay to Reach 90 Percent of Baseline If Anticipated by Zero, One, or Two Years, Officers**

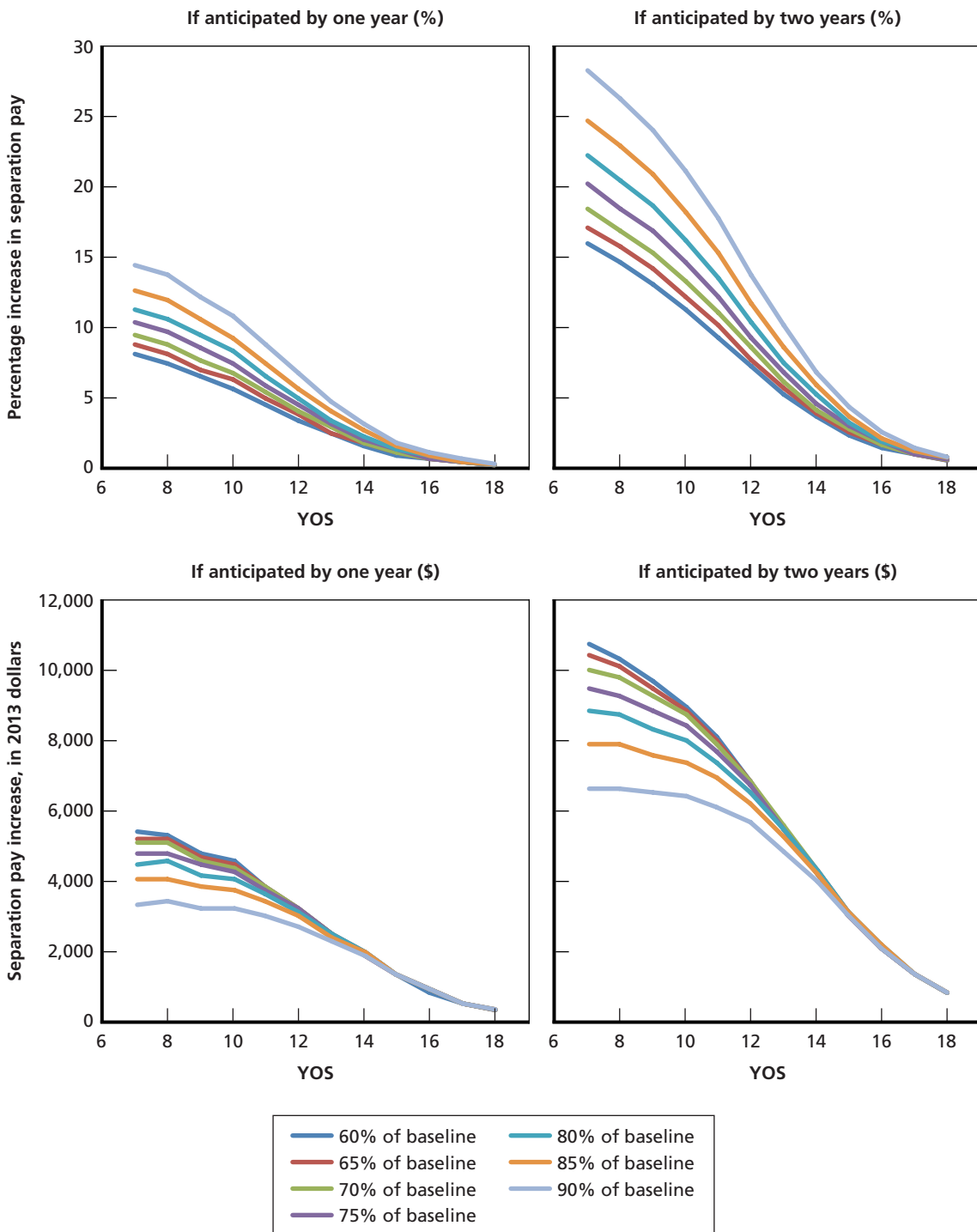


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paid at the outset in one-, two-, or three-year windows, and we include this expenditure in the calculation.



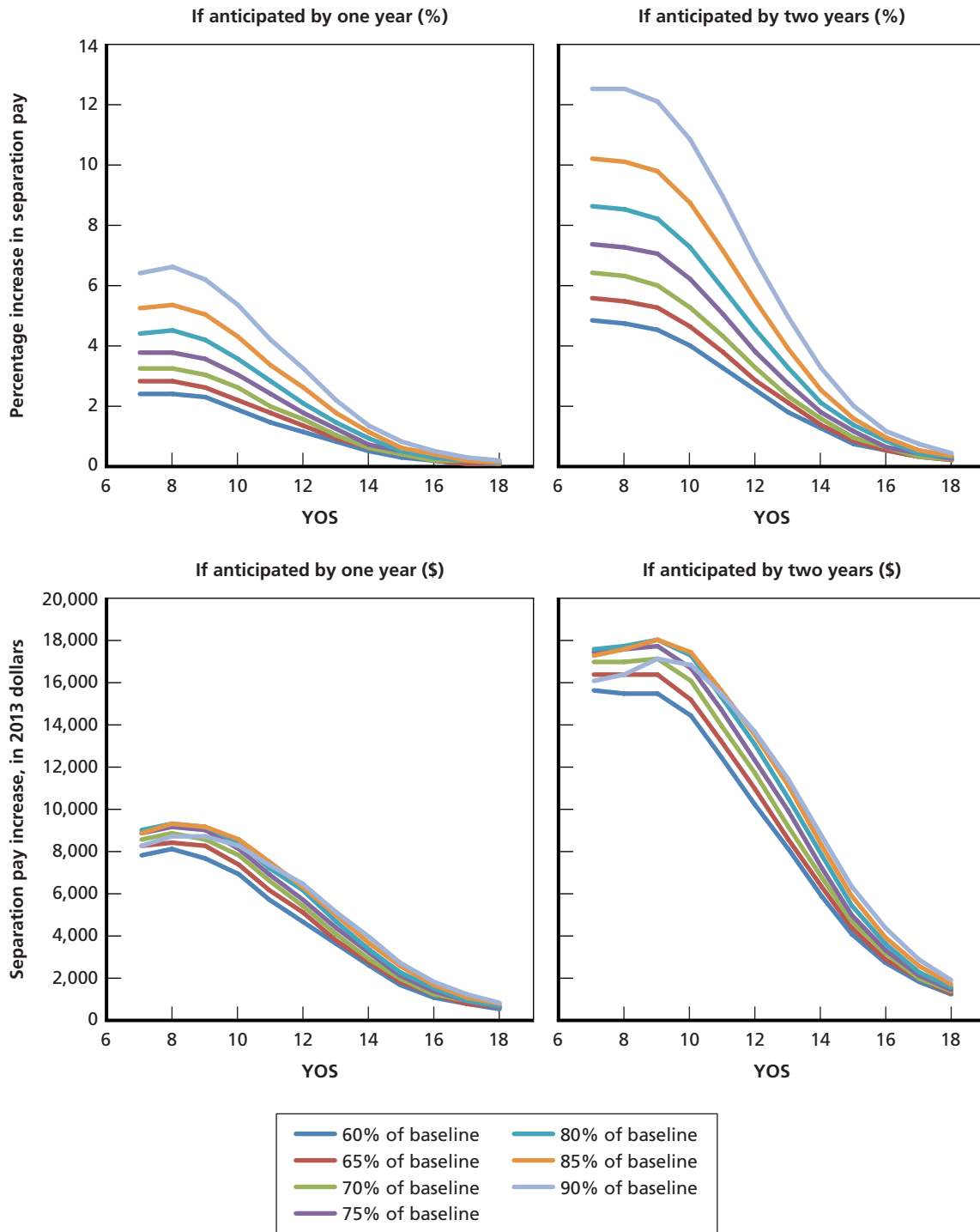
**Figure 4.18**  
**Increase in Required Voluntary Separation Pay If Anticipated by One or Two Years, Enlisted**



RAND RR545-4.18

As in our earlier discussion, the greatest net cost decreases are for a one-year window and for a force-wide drawdown (i.e., the least focused drawdown), and this remains true at all three

**Figure 4.19**  
**Increase in Required Voluntary Separation Pay If Anticipated by One or Two Years, Officers**



RAND RR545-4.19

horizons. The difference in the PV between any two horizons, e.g., five years and ten years, occurs because the discount-rate guidance differs by horizon and because, at longer horizons,

**Table 4.3**  
**Present Value of the Net Decrease in Personnel Costs over Five, Ten, and 30 Years, by Scenario, for Officer and Enlisted Personnel Together, in Billions of 2013 Dollars**

Scenario	Initial Cost of VSP	PV Net Decrease		
		Over 5 Years	Over 10 Years	Over 30 Years
1-year window	2.0	2.9	7.4	10.7
2-year window	2.6	2.5	7.0	10.3
3-year window	1.7	2.1	6.6	9.9
Draw down all to 90%	2.0	2.9	7.4	10.7
Draw down half to 80%	2.4	2.5	7.0	10.4
Draw down one-quarter to 60%	3.0	1.8	6.4	9.9

NOTE: The change in personnel costs is only for personnel leaving in the years covered by the VSP, YOS 7 through 18. Discounting is done in accordance with OMB Circular A-94 (OMB, 1992), using real discount rates provided in Appendix C as updated in December 2012.

there have been more years of cost avoidance for the separated personnel. Also, personnel cost decreases continue to mount into the future. The PVs show, however, that three-fourths of the decreases have been realized by ten years from policy implementation.



## Concluding Thoughts

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We review the main findings and discuss VSP with respect to ISP, VSI, and SSB.

### Key Findings

- VSP can draw down the force rapidly without creating an imbalance in the experience mix of personnel (a bathtub).
- A higher VSP is needed to make a deeper cut in force size, but net personnel costs decrease even so.
- A lower VSP offered for multiple years can achieve the same end-strength goal as a VSP offered for one year, but net decreases in personnel costs are lower because more personnel remain on hand while the VSP is offered.
- If members anticipate being offered a VSP, a higher VSP is required to reach a given target.
- A 10-percent cut in the force would produce a net decrease in PV of AC Army personnel costs of \$6.4 billion to \$7.4 billion over the first ten years.
- The cost of implementing VSPs is \$1.7 billion to \$3 billion for a 10-percent cut in the force, depending on whether the VSP is implemented for a window of one, two, or three years and the cut is across the board or concentrated on a portion of the force.
- VSPs can be targeted to particular groups, e.g., poorer performers or personnel in over-strength occupations, and thereby induce separations from those groups.

### Comparing Voluntary Separation Pay with Involuntary Separation Pay, Voluntary Separation Incentive, and Special Separation Bonus

#### Targeting

VSP, ISP, VSI, and SSB can be targeted. A service can set eligibility criteria to focus on lower-performing members, for instance. This can be done along with actions that do not have a budget cost: lower accessions, early outs, tighter physical standards, tighter time-in-grade standards, tighter promotion selection standards, and longer time to promotion (because of a decrease in force structure and spaces). ISP, VSI, and SSB are paid by formulas depending on basic pay and YOS, while the DRM calculates VSP. The model has not yet been estimated for specific groups that might be targeted, but it could be.

### Cost, Uncompensated Value, and Rent

The cost of implementing ISP, VSI, SSB, and VSP will depend on where the force is cut and how deeply. Because ISP, VSI, and SSB are computed by a preset formula, their budget cost is simply the number cut in each basic pay/YOS cell times the ISP, VSI, or SSB for that cell. The cost of VSP at a given YOS depends on the number of individuals opting to leave times the VSP for that YOS, which is a function of the depth of the cut. In contrast, ISP, VSI, and SSB amounts are independent of the size of the reduction.

Tables 5.1 and 5.2 illustrate the per-person cost of ISP and VSP for enlisted members and officers. (VSI and SSB are no longer available.) The VSP amounts are for a one-year implementation not announced ahead of time. ISP and VSP for a 10-percent enlisted drawdown are nearly equal except at YOS 16 and 18. Apart from those years, there is little difference between the costs of these two approaches. For drawdowns greater than 10 percent, ISP remains the same, but VSP increases with the depth of the drawdown. For officers, VSP exceeds ISP for a 10-percent drawdown, and VSP increases for higher drawdowns, while ISP remains at the

**Table 5.1**  
Involuntary and Voluntary Separation Pay Payments, by Extent of Drawdown, Enlisted, in Thousands of 2013 Dollars

Percentage Decrease	8 YOS		10 YOS		12 YOS		14 YOS		16 YOS		18 YOS	
	ISP	VSP	ISP	VSP	ISP	VSP	ISP	VSP	ISP	VSP	ISP	VSP
10	26	25	35	30	44	41	59	59	68	88	90	126
15	26	34	35	40	44	53	59	73	68	103	90	142
20	26	43	35	50	44	63	59	84	68	116	90	155
25	26	50	35	58	44	72	59	94	68	126	90	166
30	26	57	35	65	44	81	59	103	68	135	90	175
35	26	64	35	73	44	89	59	111	68	144	90	183
40	26	71	35	80	44	96	59	119	68	152	90	191

**Table 5.2**  
Involuntary and Voluntary Separation Pay Payments, by Extent of Drawdown, Officers, in Thousands of 2013 Dollars

Percentage Decrease	8 YOS		10 YOS		12 YOS		14 YOS		16 YOS		18 YOS	
	ISP	VSP	ISP	VSP	ISP	VSP	ISP	VSP	ISP	VSP	ISP	VSP
5	51	79	68	98	94	133	115	197	136	285	171	368
10	51	132	68	156	94	200	115	273	136	367	171	452
15	51	173	68	201	94	248	115	325	136	421	171	507
20	51	209	68	238	94	288	115	366	136	463	171	548
25	51	241	68	272	94	323	115	402	136	498	171	583
30	51	271	68	303	94	355	115	434	136	530	171	614
35	51	299	68	332	94	384	115	463	136	558	171	642
40	51	327	68	360	94	412	115	491	136	586	171	669

same level. For example, at 12 YOS, ISP for enlisted is about \$44,000, and VSP is \$41,000 for a 10-percent drawdown and \$96,000 for a 40-percent drawdown. ISP for officers at 12 YOS is \$94,000, and VSP is \$133,000 for a 5-percent drawdown, \$200,000 for a 10-percent drawdown, and \$412,000 for a 40-percent drawdown. Also, for a drawdown of a given size, the required VSP increases nonlinearly with YOS. The VSP for a 10-percent enlisted drawdown is \$44,000 at 12 YOS, \$88,000 at 16 YOS, and \$126,000 at 18 YOS. The respective VSPs for officers are \$200,000, \$367,000, and \$452,000.

But as noted in Chapter Four, the roles of ISP and VSP are fundamentally different. ISP is a payment to members selected by and involuntarily separated by the service. VSP is a payment to members who self-select and voluntarily choose to separate from the service. The VSP amounts computed by the DRM are for self-selection and voluntary separation and are not intended to indicate the amount of VSP required to cut a given number of people from a population of members designated for *involuntary* separation.

Under voluntary separation, VSP induces the  $n$ th member to separate to meet a drawdown of  $n$  members. This amount is higher than needed to separate the  $n - 1$  others, so they receive rent (are paid more than they would be willing to accept to leave). VSP is an appropriate tool when well-performing personnel must be cut because of a general drawdown. Under involuntary separation, ISP can often be less than a member would be willing to accept to leave voluntarily, and, if so, the member suffers a loss. The service sets the criteria for involuntary separation, and there could be negative externalities if members think the criteria are unfair (do not have the same bearing across occupations, experience, or demographic groups), inaccurate or imprecise (poorly discriminate among personnel based on their performance), or too deep (the criteria are perceived to be valid for identifying the very lowest performers but invalid when affecting a larger portion of the force). Also, many of those selected for involuntary separation might feel that ISP is not fair compensation. Equally important, those not selected might disapprove of the extensive use of an involuntary mechanism in a volunteer force and think that it breaks faith with them.

In summary, involuntary separations seem appropriate for relatively small cuts of perhaps 10 percent or less and when criteria are meaningful to the service and perceived as valid by service members. Deeper involuntary separations and less valid criteria, however, could create negative externalities among members, a hidden cost. Also, if involuntary separations are not carefully done, they could create bathtubs. Voluntary separations under VSP provide a balanced experience mix and avoid negative externalities, but they are more costly, especially for deeper cuts, and deprive the service of controlling who separates apart from setting the criteria to define the eligible population.





## The Dynamic Retention Model

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The following material comes from Asch, Hosek, and Mattock, 2013, pp. 81–88, and is reproduced here for the convenience of the reader. Note that we make one correction to the final paragraph, which refers to the BHHH method and cites Berndt et al., 1974. BHHH (better known as the outer-product-of-gradients method) is a means of approximating the variance–covariance matrix as a precursor to computing standard errors and has nothing to do with optimization. The method that was used for optimization was Broyden–Fletcher–Goldfarb–Shanno (BFGS) (Broyden, 1970). The corrected text would read as follows:

We use the Broyden–Fletcher–Goldfarb–Shanno (BFGS) hill-climbing algorithm to optimize the likelihood function (Broyden, 1970). We compute standard errors by numerically differentiating the likelihood function, evaluated at parameter estimates to produce a matrix of second derivatives, or Hessian matrix. The standard errors are the square root of the absolute value of the diagonal of the inverse of the Hessian.

## APPENDIX B

**The Active/Reserve Dynamic Retention Model**

As discussed in Chapter Two, the model is a stochastic dynamic programming model of active retention and reserve participation at the individual level. The model is a theoretical basis for describing behavior where the individual is assumed to be rational and forward looking. In dynamic programming models, the current state depends on history, i.e., on the sequence of past states, and the decision taken in each period. The model is stochastic in the sense that in each period random factors enter the decision. There is a realization of the random factors in each period once it is reached. The realizations in future periods are not known in the current period, but the individual is assumed to know the distribution from which the random factors are drawn and can use this knowledge in developing an expected value of the future consequences of the current-period choice. The following expressions give the structure of the model. Again, the model is defined at the individual level, however, the individual subscript is suppressed for brevity.

$$Y_{jkt}(s_t, \varepsilon_{kt}; \gamma) = w_{kt} + \gamma_k + \beta \text{Emax}(Y_{ka}(s_{t+1}, \varepsilon_{at+1}; \gamma), Y_{kr}(s_{t+1}, \varepsilon_{rt+1}; \gamma), Y_{kc}(s_{t+1}, \varepsilon_{ct+1}; \gamma)) + \varepsilon_{kt} \quad (\text{B.1})$$

$Y_{jk}$  = value function for transition from  $j$  to  $k$ ,  $j, k \in \{\text{active, reserve, civilian}\}$   
 $s_t = (ay_t, ry_t, t)$  where  $ay$  = active years,  $ry$  = reserve years,  $t$  = total years  
 $w_{kt}$  = current pay in  $k$  at  $t$

$$\gamma_k = \begin{cases} \gamma_a & \text{monetary value of preference for serving in AC} \\ \gamma_r & \text{monetary value of preference for serving in RC} \\ 0 & \text{preference for civilian job} \end{cases}$$

$\beta$  = personal discount factor

$\text{Emax}$  = expected value of the maximum

$\varepsilon_{kt}$  = random shock in  $k$  at  $t$ .

The model is generally structured to allow movement between active, reserve, and civilian statuses, but in applying the model we do not permit an individual who leaves an active component to reenter. This decreases the state space, which facilitates the estimation of the model, and reflects the fact that reentry is relatively rare. The value function  $Y_{jkt}$  subscripts indicate current status  $j$ , a status  $k$  that the individual can enter next period from  $j$ , and the time period. The value function is additively separable in the current pay in  $k$ , the monetary value of taste in  $k$ , the present value of being able to choose the best alternative in the following period given  $k$  in the current period, and the random shock in  $k$  in the current period.

The state,  $s_t$ , is defined in terms of active years, reserve years, and total years accumulated as of period  $t$ . Current pay depends on the state. Active pay is average annual regular military compensation given the number of active years and reserve years. Reserve pay is a fraction of reserve annual regular military compensation under the assumption that a reservist accumulates 75 points in a year and receives 75/360 of annual reserve RMC (Appendix A). Pay as a reservist, i.e., in the reserve status, is the sum of reserve pay and civilian pay, an approach that assumes reservists are also employed in civilian jobs. Civilian pay depends on total years. In addition, pay in the civilian status includes the present discounted value of the active or reserve military retirement benefit payment if the individual is eligible to receive it.

The term  $\gamma_k$  is the monetary value of the individual's preference relative to the civilian sector; i.e.,  $\gamma_a$  for active service and  $\gamma_r$  for reserve service. The personal discount factor,  $\beta$ , is defined as  $1/1 + r$ , where  $r$  is the personal discount rate. The operator  $E_{\max}$  gives the expected value of the *maximum* of the value functions in the next period. The  $E_{\max}$  expression reflects the fact that the individual can reoptimize in the next period once the random shocks in that period have been realized. The current period assessment of the value of the best choice tomorrow is the expected value of the maximum of tomorrow's choices. The term  $\varepsilon_{kt}$  is the random shock in status  $k$  in period  $t$ .

The model is structured as a Markov process. In the next period there is a chance that any allowable status can be entered. Further, because the state is assumed to capture all relevant information from the individual's history and the random shocks are uncorrelated, it is possible to partition the expected value of the maximum given the current state. Using this insight, the model also can be written:

$$Y_{jkt}(s_t) = w_{kt} + \gamma_k + \beta \sum_m \pi_{km}(s_{t+1} | s_t) Y_{km}(s_{t+1}) + \varepsilon_{kt}$$

$$\pi_{km}(s_{t+1} | s_t) = \text{probability alternative } m \text{ is } \max(Y_{km}(s_{t+1})), m \in \{a, r, c\}. \quad (\text{B.2})$$

The model assumes that a reservist holds a civilian job. This is a simplifying assumption because some reservists are full-time students, unemployed, or out of the labor force, but the idea is that participation in the reserves is concurrent with another main activity, a job. Therefore, a civilian job shock will be present in both the civilian and reserve statuses.

To allow for error correlation between the reserve and civilian alternatives, we use a nested logit form where these alternatives represent one nest and the active alternative is the other nest. The choice is between the active alternative and the better alternative in the reserve/civilian nest, i.e., the maximum of the reserve alternative and the civilian alternative. To shorten notation, we rewrite Equation B.1 as  $Y_{kj}(s_t) = V_j + \varepsilon_j$ , where  $V_j$  represents the non-stochastic terms on the right side, and the other arguments and time subscript have been omitted. Adapting the treatment of Ben-Akiva and Lerman (1985), we develop the nested logit specification from the following expressions:

$$\max[V_r + \omega_r, V_c + \omega_c] + v_{rc}. \quad (B.3)$$

The first expression in Equation B.3 corresponds to the active alternative, and the second expression corresponds to the reserve/civilian nest alternative. The active alternative can be thought of as a nest with a single element. The nested logit model assumes that  $\varepsilon_a$  has the same distribution as the sum of the errors in the second expression, so we need to ensure that this requirement is met. Also, we assume that all errors are generated from extreme value distributions. When the errors have the same extreme value distribution, and in particular have the same variance, then the choice between the nests has the logit form. Train (2003) provides a proof that when alternatives have identically distributed, independent extreme-value errors, the probability that a particular alternative is the maximum has a logit form. Ben-Akiva and Lerman (1985) show that the nested logit model can be written as a choice between alternatives, each of which is the maximum choice from its nest. As we show for our model, the errors of these maximum choices can be constructed to have the same variance; hence, Train's proof applies.

The extreme value distribution  $EV[a, b]$  has the form  $e^{-e^{-(a-x)/b}}$  with mean  $a + b\gamma$  and variance  $\pi^2 b^2 / 6$ , where  $\gamma$  is Euler's Gamma ( $\approx 0.577$ ),  $a$  is the location parameter, and  $b$  is the scale parameter. The variance is proportional to the square of the scale parameter, and we use the fact that equal scale parameters imply equal variances. Let  $\omega_r$  and  $\omega_c$  in Equation B.3 be within-nest errors drawn from an extreme-value distribution  $EV[0, \lambda]$  and let  $v_{rc}$  be the nest-specific error for the reserve/civilian nest in Equation B.3, distributed as  $EV[0, \tau]$ . In other words,  $v_{rc}$  can be thought of as a shock that affects both the reserve and the civilian alternatives, whereas  $\omega_r$  and  $\omega_c$  affect each alternative separately.

It is known that  $\max[V_r + \omega_r, V_c + \omega_c]$  also follows an extreme-value distribution with the same scale as for  $\omega_r$  and  $\omega_c$  but a different mean, namely,  $EV[\lambda \ln(e^{V_r/\lambda} + e^{V_c/\lambda}), \lambda]$ . Notice that this mean is positive, assuming  $V_r$  and  $V_c$  are positive, whereas the distribution for  $\omega_r$  and  $\omega_c$  has a zero mean. Intuitively, the expected value of being able to choose the larger of two random draws, each with zero mean, is greater than zero. We rewrite the second expression in Equation B.3 as follows:

$$\begin{aligned} & \lambda \ln(e^{V_r/\lambda} + e^{V_c/\lambda}) + \omega'_{rc} + \nu_{rc}, \text{ where} \\ \omega'_{rc} &= \max[V_r + \omega_r, V_c + \omega_c] - \lambda \ln(e^{V_r/\lambda} + e^{V_c/\lambda}) \\ \omega'_{rc} &\sim EV[0, \lambda]. \end{aligned} \quad (\text{B.4})$$

Define  $\varepsilon_{rc} = \omega'_{rc} + \nu_{rc}$ . It is the sum of two independent, differently distributed extreme-value variables. The error  $\omega'_{rc}$  is the single error associated with taking the maximum of  $V_r + \omega_r$  and  $V_c + \omega_c$ , and the definition of  $\omega'_{rc}$  ensures that its mean is zero. Further,  $\nu_{rc}$  is the single error at the nest level. The distributions of  $\omega'_{rc}$  and  $\nu_{rc}$  have the same location parameter (zero), but different scale parameters. In general, the variance of the sum of two independent random variables is the sum of the variances, so the variance of  $\varepsilon_{rc} = \omega'_{rc} + \nu_{rc}$  is  $(\pi^2(\lambda^2 + \tau^2))/6$ , implying a scale parameter for the R/C nest of  $\sqrt{\lambda^2 + \tau^2}$ . It follows that  $\varepsilon_{rc} \sim EV[0, \sqrt{\lambda^2 + \tau^2}]$ . We also want  $\varepsilon_a$  to have the same distribution (i.e., the same location and scale parameters), so we set  $\varepsilon_a \sim EV[0, \sqrt{\lambda^2 + \tau^2}]$ . For brevity, let  $\kappa = \sqrt{\lambda^2 + \tau^2}$ .

Drawing this together, the model may be written as follows:

$$\begin{aligned} & V_a + \varepsilon_a \\ & \lambda \ln(e^{V_r/\lambda} + e^{V_c/\lambda}) + \varepsilon_{rc} \\ \varepsilon_a, \varepsilon_{rc} &\sim EV[0, \kappa]. \end{aligned} \quad (\text{B.5})$$

Assuming that the individual chooses the higher-valued alternative, this leads to a probability of choosing *active* that has the logit form, as Train (2003) showed:

$$\begin{aligned} \Pr(\text{active}) &= \frac{e^{V_a/\kappa}}{e^{V_a/\kappa} + e^{\frac{\lambda \ln(e^{V_r/\lambda} + e^{V_c/\lambda})}{\kappa}}} \\ &= \frac{e^{V_a/\kappa}}{e^{V_a/\kappa} + (e^{V_r/\lambda} + e^{V_c/\lambda})^{\lambda/\kappa}}. \end{aligned} \quad (\text{B.6})$$

The second line follows from the fact that  $e^{b \ln a} = a^b$ .

The within-nest error terms,  $\omega$ , are distributed  $EV[0, \lambda]$  and the “total” error terms,  $\varepsilon$ , are distributed  $EV[0, \sqrt{\lambda^2 + \tau^2}]$ .

Therefore, the fraction of the error variance accounted for by the within-nest, choice-specific, portion of the total error is

$$\frac{\lambda^2}{\tau^2 + \lambda^2}. \quad (\text{B.7})$$

It follows that the fraction of the error variance attributable to the within-nest common shock is one minus this amount, or  $\tau^2 / (\tau^2 + \lambda^2)$ .

As a thought experiment, we can think of the problem of selecting the best alternative from the nest as choosing between

$$\frac{V_r + \omega_r + \nu_{rc}}{V_c + \omega_c + \nu_{rc}} \quad (\text{B.8})$$

The correlation between these two total utilities (viewed by themselves before one has been chosen) is

$$\begin{aligned} \rho &= \frac{\text{Cov}[V_r + \omega_r + \nu_{rc}, V_c + \omega_c + \nu_{rc}]}{\sqrt{\text{Var}[V_r + \omega_r + \nu_{rc}]} \sqrt{\text{Var}[V_c + \omega_c + \nu_{rc}]}} \\ &= \frac{\tau^2}{\tau^2 + \lambda^2} . \end{aligned} \quad (\text{B.9})$$

As shown in Equation B.9, a larger variance of the common shock results in a larger correlation between the reserve and civilian alternatives. Thus, the nested logit formulation succeeds in giving us a specification that allows the shocks to the reserve and civilian alternatives to be correlated, and the greater the common shock, the greater the correlation.

Applying the rule above for the distribution of the maximum of two values, we see that

$$\begin{aligned} \max[V_a + \varepsilon_a, \lambda \ln(e^{V_r/\lambda} + e^{V_c/\lambda}) + \varepsilon_{rc}] &\sim EV \left[ \kappa \ln \left( e^{V_a/\kappa} + e^{\lambda \ln(e^{V_r/\lambda} + e^{V_c/\lambda})/\kappa} \right), \kappa \right] \\ EV \left[ \kappa \ln \left( e^{V_a/\kappa} + e^{\lambda \ln(e^{V_r/\lambda} + e^{V_c/\lambda})/\kappa} \right), \kappa \right] &= EV \left[ \kappa \ln \left( e^{V_a/\kappa} + (e^{V_r/\lambda} + e^{V_c/\lambda})^{\lambda/\kappa} \right), \kappa \right]. \end{aligned} \quad (\text{B.10})$$

As before, the second line follows from  $e^{b \ln a} = a^b$ .

Applying the formula for the mean of an extreme-value distribution to Equation B.10, the expected value of the maximum of the two alternatives (active versus the maximum of reserve/civilian), is

$$\kappa \left( \gamma + \ln \left[ e^{V_a/\kappa} + (e^{V_r/\lambda} + e^{V_c/\lambda})^{\lambda/\kappa} \right] \right). \quad (\text{B.11})$$

Further, given that active is not an option, the expected value of the maximum of the two alternatives (reserve and civilian) is

$$\begin{aligned} &\kappa \left( \gamma + \ln \left[ (e^{V_r/\lambda} + e^{V_c/\lambda})^{\lambda/\kappa} \right] \right) \\ &= \kappa \gamma + \lambda \ln [e^{V_r/\lambda} + e^{V_c/\lambda}]. \end{aligned} \quad (\text{B.12})$$

The first line of Equation B.12 does not contain the term  $e^{V_a/\kappa}$  because the constraint that the individual cannot reenter the active component means, in effect, that  $V_a$  is set to negative infinity, and  $e^{-\infty} = 0$ . The second line simplifies the log expression.

The expected value of the maximum of a set of choices is referred to as the surplus function, and the surplus function can be used to derive choice probabilities. The Williams-Daly-Zachary Theorem (see McFadden, 1981) states that the probability of choosing a given alternative equals the partial derivative of the surplus function with respect to the value of the alternative. Thus, the probability of choosing to remain in an active component is as follows:

$$\begin{aligned} \Pr(\text{active}) &= \frac{\partial \kappa \left( \gamma + \ln \left[ e^{V_a/\kappa} + (e^{V_r/\lambda} + e^{V_c/\lambda})^{\lambda/\kappa} \right] \right)}{\partial V_a} \\ &= \frac{e^{V_a/\kappa}}{e^{V_a/\kappa} + (e^{V_r/\lambda} + e^{V_c/\lambda})^{\lambda/\kappa}}. \end{aligned} \quad (\text{B.13})$$

This is the same as that shown in Equation B.6, which replicated the usual logit specification. To emphasize the meaning of Equation B.13, we restate it as

$$PR(V_a + \varepsilon_a > \lambda \ln(e^{V_r/\lambda} + e^{V_c/\lambda}) + \varepsilon_{rc}) = \frac{e^{V_a/\kappa}}{e^{V_a/\kappa} + (e^{V_r/\lambda} + e^{V_c/\lambda})^{\lambda/\kappa}}.$$

By the same approach, the probabilities of choosing reserve and civilian are

$$\begin{aligned} \Pr(\text{reserve}) &= \frac{(e^{V_r/\lambda} + e^{V_c/\lambda})^{\lambda/\kappa}}{e^{V_a/\kappa} + (e^{V_r/\lambda} + e^{V_c/\lambda})^{\lambda/\kappa}} \frac{e^{V_r/\lambda}}{e^{V_r/\lambda} + e^{V_c/\lambda}} \\ \Pr(\text{civilian}) &= \frac{(e^{V_r/\lambda} + e^{V_c/\lambda})^{\lambda/\kappa}}{e^{V_a/\kappa} + (e^{V_r/\lambda} + e^{V_c/\lambda})^{\lambda/\kappa}} \frac{e^{V_c/\lambda}}{e^{V_r/\lambda} + e^{V_c/\lambda}}. \end{aligned} \quad (\text{B.14})$$

Given that the individual has left the active component and cannot reenter it, the probabilities of choosing reserve or civilian are, respectively,

$$\begin{aligned} \Pr(\text{reserve} | \text{inactive}) &= \frac{\partial (\kappa \gamma + \lambda \text{Log} [e^{V_r/\lambda} + e^{V_c/\lambda}])}{\partial V_r} = \frac{e^{V_r/\lambda}}{e^{V_r/\lambda} + e^{V_c/\lambda}} \\ \Pr(\text{civilian} | \text{inactive}) &= \frac{\partial (\kappa \gamma + \lambda \text{Log} [e^{V_r/\lambda} + e^{V_c/\lambda}])}{\partial V_c} = \frac{e^{V_c/\lambda}}{e^{V_r/\lambda} + e^{V_c/\lambda}}. \end{aligned} \quad (\text{B.15})$$

A comparison of Equations B.14 and B.15 shows that the probability of choosing to be a reservist equals the probability of choosing the reserve/civilian nest multiplied by the probability of choosing reserve, given that the individual is in the nest. A similar statement holds for the probability of choosing to be a civilian.

The model provides structure regarding the choice among alternatives. The choice is modeled to depend additively on current pay, taste for active or reserve service, current shock, and the expected value of rational choice among alternatives in the uncer-

tain future, i.e., the expected value of the maximum. Further structure comes from assuming the individual knows the shock variances and so has the information needed to compute the expected value of the maximum. The individual also knows the civilian, reserve, and active pay lines. With this information, along with knowing the current state and shock draws, the individual can solve the problem and determine which alternative is best.

The position of the analyst is different. The analyst does not know the individual's tastes for active and reserve service, nor the current shocks, but is assumed to know their type of distribution. In particular, we assume that tastes follow a bivariate normal distribution and shocks follow generalized extreme value distributions, as assumed in the nested logit model. The bivariate normal distribution has five parameters: mean active taste, mean reserve taste, active taste variance, reserve taste variance, and active-reserve taste covariance or correlation. The extreme value distributions for the shocks have zero location parameters and non-zero scale parameters, hence non-zero variances.

In addition, we include the personal discount factor and switching cost parameters. The latter represent the cost of switching across states. There are switching costs for switching from active in the first two years of active service, switching from active in later years, and switching from civilian to reserve status. Estimation of the model involves finding the taste, shock, personal discount, and switching cost parameters that fit the data best, where the data consist of longitudinal observations on the individual's sequence of active, reserve, and civilian statuses over the work life.

Unlike the individual, who is assumed to have the information to make an explicit choice each period, the analyst does not have information about the individual's tastes or shocks. But the analyst can make use of the model and the functional form of the shock distributions to write an expression for the probability of a particular choice given the individual's state, and in this way can compose an expression for likelihood for the sequence of statuses over the individual's career. Still, this expression is conditional on the individual's tastes. Because these tastes are unknown to the analyst, they need to be integrated out of the expression, where the integration uses the assumption that the tastes have a bivariate normal distribution.

In estimation, the integration is done numerically. For each individual, a Halton sequence of 23 pairs of active and reserve seed tastes is drawn and then, using trial values of the taste distribution parameters, the Halton draws are translated as though they were drawn from the distribution of tastes given the trial values of the parameters. The translation is done via a Cholesky decomposition (Appendix C). For each resulting pair, the dynamic program is solved, giving values of the value functions at each decision point and hence values of the individual's career likelihood. The integration over tastes is accomplished by taking the average of the likelihoods over the 23 valuations.

The process of estimation tries different values of the parameters until the career likelihoods are maximized for the sample of service members used in the estimation. In many respects, this is standard maximum likelihood estimation, but it differs in



two ways. First, the model has a specific structure for the value function, as mentioned above. Second, for each set of trial parameters, the dynamic programming problem must be re-solved for all periods for all 23 pairs of taste draws for each individual. Then, given the new solution of the model, the choice probabilities are updated, and the likelihood function is reevaluated to determine whether the fit has improved and in what direction the distribution parameters should be further changed in proceeding to the next iteration of estimation. Re-solving the dynamic program requires extensive computation. Estimating the Hessian matrix to determine the optimal direction of change is also computationally time consuming.

As the estimation algorithm iterates, we can think of the effect of changing the shock variances while holding constant the taste distribution parameters. An increase in a shock variance improves the fit if it does a better job of accounting for transitions from active to reserve, active to civilian, civilian to reserve, and reserve to civilian. That is, changing the variance affects all transitions, given any set of taste distribution parameters. Reasoning similarly, changing the mean active taste affects the fit of the active/active, active/reserve, and active/civilian transitions but not the other transitions. Changing the active taste variance helps account for dispersion in the transition probabilities from active duty. A change in the taste covariance affects the degree to which longer active careers are associated with longer reserve careers, e.g., higher transitions from civilian to reserve and lower transitions from reserve to civilians. Similar reasoning applies to the reserve taste mean and variance, with the implication that all the taste and shock parameters are identified. The personal discount rate is also estimable as it decreases future values relative to present values until the best fit is achieved. The switching cost parameters further improve the fit of the model.

We use the BHHH hill-climbing algorithm to optimize the likelihood function (Berndt et. al., 1974). We compute standard errors by numerically differentiating the likelihood function, evaluated at parameter estimates to produce a matrix of second derivatives, or Hessian matrix. The standard errors are the square root of the absolute value of the diagonal of the inverse of the Hessian.



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Office of the Secretary of Defense Cost Assessment and Program Evaluation requested RAND National Defense Research Institute help in developing an efficient means of decreasing force size. The researchers proposed the use of voluntary separation pay (VSP) and showed how it can be designed to meet drawdown goals within a certain time frame without over- or undershooting the goals. RAND's dynamic retention model determined the appropriate VSP levels by year of service to achieve drawdowns of alternative sizes for the active component Army, and the approach could be applied to other services. The analysis was done for enlisted personnel and officers and for the steady state and the transition to it.

The analysis suggests that VSPs can draw down the force rapidly without creating a hollow force or bathtub. Implementing VSPs requires an increase in outlays, but net decreases in personnel costs can still be realized even if selected military occupational specialties are cut deeply. The net decrease in personnel cost is less if a VSP is offered for multiple years, if members anticipate that a VSP will be offered in a future year, or if deeper cuts are made to portions of the force versus a shallower across-the-board cut. For a 10-percent cut in the force, net decreases range from \$6.4 billion to \$7.4 billion in 2013 dollars over the first ten years. The Army would initially require \$1.7 billion to \$3 billion to implement VSPs for such a cut, depending on how it is done.



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