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Discount Rate Analysis for Blended Retirement System Lump Sum Payments

Stanley A. Horowitz, Project Leader
David M. Tate
John T. Warner

November 2017
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IDA Paper P-8527
Log: H 17-000322

INSTITUTE FOR DEFENSE ANALYSES
4850 Mark Center Drive
Alexandria, Virginia 22311-1882

About this Publication
This work was conducted by the Institute for Defense Analyses (IDA) under contract HQ0034-14-D-0001, project BE-7-4151, "Discount Rate Analysis for Retirement Options," for the Director for Military Compensation, Office of the Assistant Secretary of Defense (Manpower and Reserve Affairs), Office of the Under Secretary of Defense (Personnel and Readiness). The views, opinions, and findings should not be construed as representing the official position of either the Department of Defense or the sponsoring organization.

Acknowledgments
Thank you to Matthew S. Goldberg, David R. Graham, and Nancy M. Huff for performing technical review of this document.

For More Information:
Stanley A. Horowitz, Project Leader
shorowit@ida.org, (703) 575-4685

David J. Nicholls, Director, Cost Analysis and Research Division
dnicholl@ida.org, (703) 575-4991

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Executive Summary

Sections 631 through 636 of The National Defense Authorization Act for Fiscal Year (FY) 2016 (NDAA 2016) established a new Blended Retirement System (BRS) for military personnel. One provision of the BRS is that retiring Service members with 20 or more years of service (YOS) have the option to receive a lump sum payment at separation in lieu of either 25 percent or 50 percent of the annuity payments they would have received during the "second career" period of retirement.[1] The law further provides that the Secretary of Defense should determine the discount rate to use in calculating the value of lump sums, using average personal discount rates (PDRs) for military personnel, taking the literature on PDRs into consideration.

The Institute for Defense Analyses (IDA) was asked to:

- Review the literature regarding the PDRs of military personnel
- Review other sources of information on discount rates used for making similar calculations of lump sum payments in lieu of a stream of deferred payments
- Estimate the proportion of Active Duty and Reserve personnel expected to opt for a lump sum distribution at retirement, as a function of the discount rate selected by the government
- Estimate the cost implications to the government of the choice of discount rate used to compute lump sum equivalents
- Estimate the effect of the choice of discount rate on retention behavior of officer and enlisted personnel
- Characterize and quantify the pros and cons of alternative methods for selecting discount rates to be used to compute lump sum equivalents

The Department of Defense (DoD) Executive Working Group (EWG) agreed on six principles to guide DoD's selection of a discount rate:

1. Be consistent with the law. That is, use average personal discount rates of military personnel consistent with the text of Section 1415 of NDAA 2016.

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[1] The affected portion of the annuity is the stream of retirement payments made from the date of retirement until the Servicemember reaches full retirement age, as defined by the Social Security Administration. At present, full retirement age is 67 years.

2. Provide choice but do not appear to advocate for a particular choice.
3. Provide acceptable reasons either for setting the discount rate the same for all military personnel or for setting different discount rates for different classes of military personnel.
4. Use rates that are not seen as "unfairly high."
5. At worst, be cost-neutral to the Military Retirement Fund (MRF).
6. Do not unduly affect retention.

PDRs in the Literature

The literature on PDRs of military personnel is largely based on analysis of two "natural experiments." The first provided incentives to voluntarily leave the military during the downsizing of the early 1990s. Separatees were offered a choice of a stream of payments or a lump sum. Warner and Pleeter (2001) analyzed these decisions and estimated a mean real (after removing the effects of inflation) PDR of 12 to 13 percent for military separatees.[2] In our analysis we generally refer to an average PDR of between 12 and 13 percent as Drawdown-like.

The second natural experiment involved the behavior of Service members offered a choice of retirement systems between 2001 and 2007. Individuals who had joined the military after 1986 were enrolled in a less generous retirement system known as REDUX. In 2000, the Congress allowed these Service members to choose whether to convert back to the traditional "High-3" retirement system or to stay in REDUX and receive a lump sum payment of $30,000, called the Career Status Bonus. Personnel had to make their choice during their fifteenth year of service. Simon, Warner, and Pleeter (2015) found that the choices made indicated much lower PDRs than were found by the Drawdown study.[3] We refer to an average PDR of 5.7 percent as REDUX-like.

We believe that the REDUX experience better predicts BRS lump sum behavior largely because the REDUX choice reflects circumstances more like those likely to pertain to the BRS lump sum decision: specifically, a voluntary retirement decision made with years of advance warning.

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[2] John T. Warner and Saul Pleeter, "The Personal Discount Rate: Evidence from Military Downsizing Programs," *American Economic Review* 91, No. 1 (March 2001): 33–53, http://www.jstor.org/stable/2677897.

[3] Curtis J. Simon, John T. Warner, and Saul Pleeter, "Discounting, Cognition, and Financial Awareness: New Evidence from a Change in the Military Retirement System," *Economic Inquiry* 53, No. 1 (January 2015): 318–34, doi: 10.1111/ecin.12146.

Similar Decisions Outside the Military

Opportunities to convert streams of payments in lump sums are provided to lottery winners and, in some circumstances, to pension recipients in both the government and private sectors. The discount rates used to make the conversion generally reflect market conditions. In today's financial markets, the real discount rates applied in the case of lottery winners are around 1 percent. Federal law establishes rates for private pension plans that are currently below 2 percent in real terms. State plans currently use real discount rates generally between 5 percent and 6.5 percent, based on more optimistic forecasts of the long-term returns on their fund investments.

Take-Rate Estimates

The fraction of retirees who will choose the lump sum option depends on both the distribution of PDRs and the government's discount rate (GDR) that will be applied to the stream of retirement payments to calculate the lump sum. We simulated the behavior of the FY 2015 cohort of DoD retirees to estimate lump sum take rates. The analysis accounted for the higher federal income tax rates that retirees will have to pay if they choose the lump sums and for the fact that some personnel would lose much of their potential Department of Veterans Affairs disability benefits.[4] Figure ES-1 shows the result of our analysis.

We simulated the behavior of DoD retirees under two alternative assumptions about their PDR distributions: one based on the Drawdown analysis and one on the REDUX analysis. Under REDUX-like assumptions (the blue curve) with low GDRs, we estimate that 36 percent of retirees would take the lump sum. Under Drawdown-like assumptions (the red curve), this would rise to 62 percent. Higher GDRs are associated with lower take rates because they imply smaller lump sums.

[4] Retirees with cumulative VA disability ratings below 50 percent will have to forgo their VA benefits until the total of the forgone benefits exceed the lump sum.

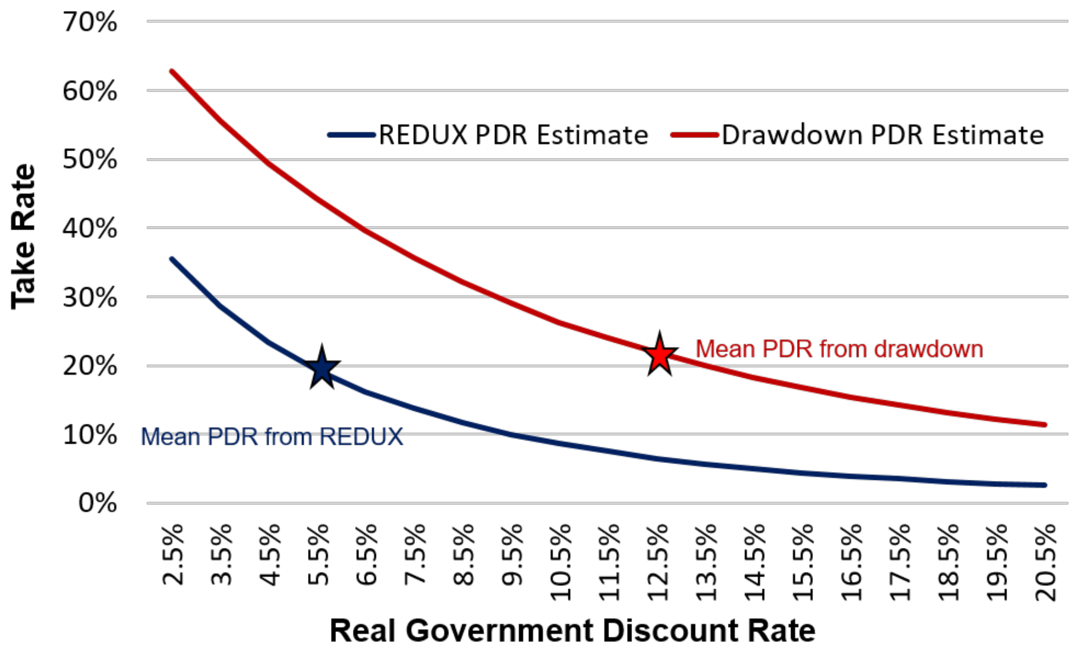

Figure ES-1. Lump Sum Take Rates as a Function of PDR Distribution and GDR Used in Calculating Lump Sums

DoD Cost Savings

We also calculated the cost implications for DoD of retirees choosing the lump sum alternative, as a function of the GDR. As the GDR rises, the size of the lump sum falls, saving DoD money for every individual who chooses the lump sum. However, also as the GDR rises, fewer people choose the lump sum. Figure ES-2 shows the trade-off of these two effects.

Government savings due to the availability of a lump sum option falls for GDRs greater than 8.5 percent if the Drawdown PDR distribution pertains. Thus, for higher GDRs, both the government and retirees selecting the lump sum are financially worse off. If the REDUX PDR distribution pertains, both the government and retirees are financially worse off for any GDRs above 6.5 percent. Savings are measured by the expected reduction in the lifetime cost of retirement payments received by individuals who retired in FY 2015.[5]

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[5] A 2.5 percent discount rate is used to convert future payments to present value. Mortality effects are not considered in the calculation.

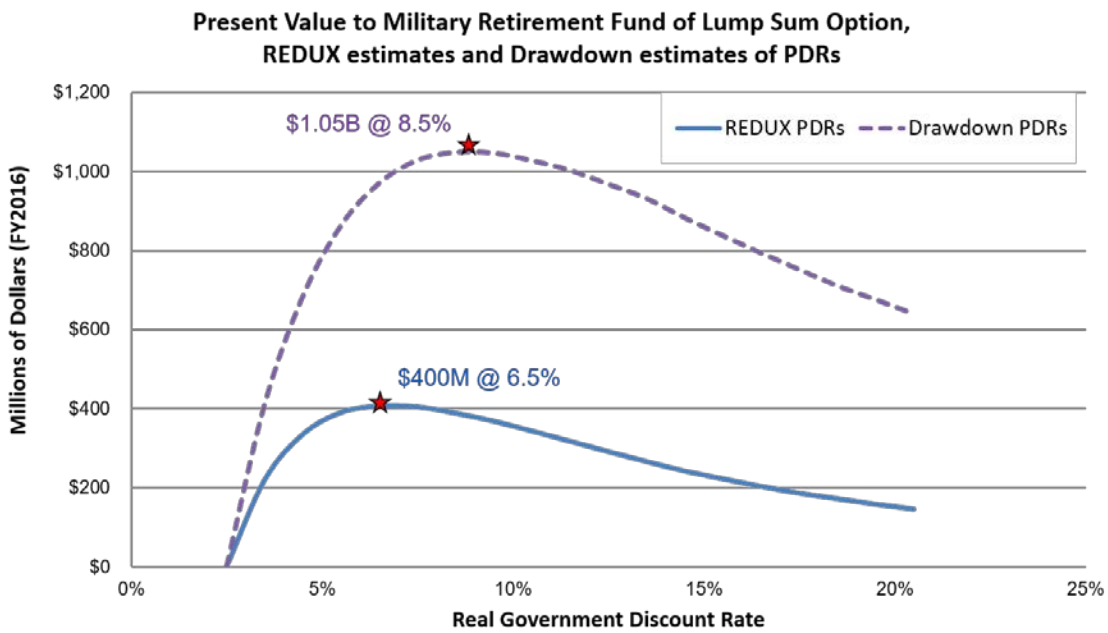

Figure ES-2. Government Savings as a Function of the Real Discount Rate Used in Calculating Lump Sums

Since the MRF is expected to yield real returns of 2.5 percent, use of a GDR below that would reduce the ability of the MRF to cover future retirement annuity payments, which would violate the EWG's guiding principles.

Retention Effects

The availability of lump sum payments may induce some additional personnel to remain in service until they reach 20 years. By the same token, it may induce some who otherwise would have remained in service for a few more years to leave shortly after that point in order to claim the lump sum. Table ES-1 shows our estimates of the impact of the lump sum option on retention through 25 YOS in terms of the percent of an entry cohort remaining in service.

Table ES-1. Change in Percent of a Cohort Remaining in Service through 25 Years of Service

PDR Distribution	2.5% GDR	7.5% GDR
Enlisted		
REDUX-like PDRs	-0.2%	0.0%
Drawdown-like PDRs	**-0.5%**	-0.2%
Officers		
REDUX-like PDRs	-0.4%	-0.1%
Drawdown-like PDRs	**-1.8%**	-0.6%

With REDUX-like PDRs, the estimated retention effect would be quite small; under Drawdown-like PDRs, they would be more substantial. If lump sums were calculated using a 2.5 percent GDR, the reduced enlisted continuation through year 25 would fall 0.5 percentage points; for officers, the decrease would be 1.8 percentage points. This amounts to 18 percent fewer enlisted personnel and 25 percent fewer officers remaining in service that long. Calculating lump sums using a 7.5 percent GDR would show an impact roughly one-third as large.

Determination of the GDR

DoD decided to use a real GDR indexed by a seven-year average of high-quality corporate bonds plus an additional amount of roughly 4 percent. This methodology yields an initial rate of 6.99 percent. Here we consider that decision in the context of the EWG guiding principles and IDA's analysis. Addressing the principles one at a time:

1. **Be consistent with the law**. That is, base the discount rate on the average PDRs of military personnel. The Drawdown experience implies an average PDR of roughly 12.2 percent. The probably more relevant REDUX experience implies an average PDR of roughly 5.7 percent. A rate of 6.99 percent is between these bounds.
2. **Provide choice but do not appear to advocate for a particular choice**. At the selected GDR, we forecast a lump sum take rate between 15 and 40 percent. A 6.99 percent rate allows for choice.
3. **Be the same for all or vary for acceptable reasons**. The link to seven-year corporate bond rates ties the value of the lump sum to prevailing economic conditions. Tying the rate to a market index is common practice in both private markets and other government pension plans. The rate will be adjusted annually. It will be different for different retiring cohorts, but in a way that does not unfairly discriminate.
4. **Use rates that are not seen as unfairly high**. There are many possible definitions of fairness. Since no retiree is compelled to choose the lump sum, one could conclude that fairness is not an issue. The American Academy of Actuaries noted, however, that:

> When lump sum payments are offered in exchange for a promised pension benefit, the Internal Revenue Code requires private pension plans to use discount rates specified through regulation that are based on high-quality corporate bond yields.… The use of a higher personal discount rate produces a smaller lump sum and results in a lump sum

amount that is not consistent with the value placed on the original annuity promised by financial markets.[6]

Consistent with the recommendation of the AAA letter, DoD is providing extensive educational material so that personnel will understand the implications of choosing the lump sum.

5. **At worst, be cost neutral to the Military Retirement Fund**. This criterion is met.

6. **Do not unduly affect retention**. The selection of a rate near 7 percent reduces the estimated impact on post-20 YOS retention relative to lower rates. We estimated the marginal attrition increase at 25 YOS, given the proposed 7 percent GDR, to be roughly 0.5 percentage points relative to the no lump sum case for officers and 0.2 percentage points for enlisted personnel if Drawdown PDR assumptions pertain. Under a REDUX-like PDR scenario, this would fall to 0.1 percentage points for officers; there would be no effect on enlisted retention.

The selected discount rate methodology makes use of IDA's analysis. It is consistent with congressional direction regarding how to select a GDR, and poses low risk to career retention levels. It is consistent with a belief that giving retirees additional voluntary choices cannot be unfair.

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[6] Letter from William R. Hallmark, Chairperson, Pension Practice Council, American Academy of Actuaries to Todd Weiler, ASD(M&RA), April 27, 2016.

Contents

1. Introduction 1
   - A. Background 1
   - B. Personal Discount Rates 2
   - C. Outline 2
2. Possible Criteria for Choosing a Discount Rate Methodology 5
3. Review of Literature on Personal Discount Rates 9
   - A. Warner and Pleeter 2001 9
   - B. Simon, Warner, and Pleeter 2015 10
4. Current Practices for Lump Sum Calculation 13
   - A. Loans and Annuities 13
   - B. Lottery Winnings 13
   - C. Distributions from Retirement Plans 15
   - D. Implications for Selection of the GDR 17
5. Estimated Lump Sum Take Rates 21
6. DoD Cost Savings 25
7. Placing the Discount Rate in Context 27
8. Effect of the Lump Sum Option on Retention 31
9. Determination of the Government Discount Rate 35

Appendix A. Technical Analysis – Review of the Literature on Personal Discount Rates A-1

Appendix B. Technical Analysis – Lump Sum Take Rate Estimation and Potential Government Savings B-1

Appendix C. Summary Statistics about the FY 2015 Retiree Cohort and Calculations Related to the Analysis C-1

Appendix D. Simulation of Income and Personal Discount Rates D-1

Appendix E. Estimation of the Probability of a Service-Connected Disability and VA Offsets E-1

Appendix F. Breakeven Discount Rates with and without Taxation F-1

Appendix G. Technical Analysis – Retention Effects G-1

Appendix H. Technical Description of the DRM H-1

Appendix I. Post-Service Earnings Functions and the Simulation of Post-Service Earnings I-1

Appendix J. Voluntary FTSP Contributions J-1

Illustrations K-1

References L-1

Abbreviations M-1

1. Introduction

A. Background

Sections 631 through 636 of the National Defense Authorization Act for Fiscal Year 2016 (NDAA 2016) established a new Blended Retirement System (BRS) for military personnel. One provision of the BRS is that retiring Service members with 20 or more years of service (YOS) have the option to receive a lump sum payment at separation in lieu of either 25 percent or 50 percent of the annuity payments they would have received during the "second career" period of retirement. The affected portion of the annuity is the stream of retirement payments made from the date of retirement until the Service member reaches full retirement age, as defined by the Social Security Administration. At present, full retirement age is 67 years. The law further provided that:

> The Secretary of Defense shall compute the discounted present value of amounts of covered retired pay that an eligible person is otherwise entitled to receive [by] estimating the aggregate amount of retired pay the person would receive for the period, taking into account cost-of-living adjustments[,] using average personal discount rates (as defined and calculated by the Secretary taking into consideration applicable and reputable studies of personal discount rates for military personnel and past actuarial experience in the calculation of personal discount rates under this paragraph); and in accordance with generally accepted actuarial principles and practices.[1]

The Director for Military Compensation, Office of the Assistant Secretary of Defense (Manpower and Reserve Affairs) asked the Institute for Defense Analyses (IDA) to perform analytical tasks in support of this requirement, including:

- Reviewing the literature regarding the personal discount rates (PDRs) of military personnel
- Reviewing other sources of information on discount rates used for making similar calculations of lump sum payments in lieu of a stream of deferred payments
- Estimating the proportion of Active Duty and Reserve personnel expected to opt for a lump sum distribution at retirement, as a function of the discount rate selected by the government

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[1] *National Defense Authorization Act for Fiscal Year 2016,* § 633(a)(2) Discounted Present Value.

- Estimating the cost implications to the government of the choice of discount rate used to compute lump sum equivalents
- Estimating the effect of the choice of discount rate on retention behavior of officer and enlisted personnel
- Characterizing and quantifying the pros and cons of alternative methods for selecting discount rates to be used to compute lump sum equivalents

This paper summarizes IDA's activities, methods, and findings with respect to those analyses.

B. Personal Discount Rates

Since they play a large role in the discussion that follows, it is important to understand the meaning of PDRs. PDRs represent individuals' willingness to trade future amounts of money for smaller amounts received sooner. Like an interest rate, they are typically stated in percent per year.

As an illustration, suppose Julia has a choice between some amount of money today or a payment of $1000 one year from now. Julia will accept as little as $900 to get the money today. We say her PDR is (1000 – 900)/1000 = 10 percent. If, instead, Julia is not willing to accept anything less than $950, we say her PDR is (1000 – 950)/1000 = 5 percent.

Different people have different PDRs.[2] The retiree population can be thought of as having a distribution of PDRs. In the context of the BRS, using a lower government discount rate (GDR) to calculate lump sums means higher lump sum payments to retirees. This, in turn, means more retirees will choose the lump sum. As the GDR is reduced, the lump sum becomes attractive to retirees with lower PDRs.

C. Outline

Chapter 2 presents the guiding principles for selecting a discount rate methodology that were agreed to by the Department of Defense (DoD) Executive Working Group (EWG) for the BRS. It also notes additional criteria that might be deemed relevant to Service members or DoD decision makers. Chapter 3 briefly summarizes our review of the literature on PDRs. A more detailed discussion of the literature is presented in Appendix A. In Chapter 4, we identify and discuss other cases in which discount rates are used to convert streams of payments into lump sum equivalents.

Moving to quantitative analysis of the BRS lump sum option, in Chapter 5 we estimate the fraction of personnel who will take the lump sum under a range of assumptions about the PDR distribution of retiring personnel. Appendix B, supported by Appendix C

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[2] Indeed, an individual's PDR may change over time or vary according to circumstances.

through Appendix F, provides additional detail on the analysis. In Chapter 6, we estimate the cost implications for the government as a function of the discount rate selected by the government. Chapter 7 draws on the preceding chapters to place the choice of a government discount rate in the context of possible PDR distributions, government savings, the preferences of retirees, and practices used in other circumstances to convert flows of funds to lump sums. In Chapter 8, we analyze the retention implications of various GDR options. Appendix G, supported by Appendix H and Appendix I, provides more detail on the retention analysis. Chapter 9 addresses DoD's decision concerning which GDR to use in the context of the guiding principles adopted by the EWG and IDA's analysis.

2. Possible Criteria for Choosing a Discount Rate Methodology

The DoD EWG for the BRS agreed on six principles to guide its selection of a GDR (or a methodology for defining a varying discount rate over time). In this chapter, we present and discuss those principles and also suggest additional criteria that might be useful in defining discount rate policy.

According to the EWG, the method for determining the lump sum should:

1. **Be consistent with the law.** That is, DoD should "use average personal discount rates (as defined and calculated by the Secretary taking into consideration applicable and reputable studies of personal discount rates for military personnel)," as stated in the NDAA.

   Consistency could be interpreted to mean that the discount rate must be an estimate of the arithmetic average PDR for military personnel. Alternatively, it could be interpreted to mean that DoD should use information about the PDR distribution to assess the implications of alternative discount rates. The EWG tended toward the former interpretation.

2. **Provide choice but not appear to advocate for a particular choice.** The availability of a lump sum option was suggested by the Military Compensation and Retirement Modernization Commission (MCRMC). Discussions with Service members indicated that some wanted to have the option of receiving a lump sum to cover major expenses or investments while individuals were employed in a second career. The EWG recognized that it was important to address this preference. Using a very low discount rate to calculated lump sums could be viewed as advocating for choosing the lump sump; using a very high discount rate could be viewed as advocating against it.

3. **Be the same or vary for acceptable reasons.** Discount rates could vary for a number of reasons. They could vary according to the PDR distributions of different sub-populations. The next chapter shows, for example, that officers tend to have lower PDRs than enlisted personnel. Women tend to have lower discount rates than men. Other demographic characteristics are also good predictors of variation in PDRs. The EWG determined that it is not appropriate for the discount rate used to calculate the size of lump sums to vary with personal characteristics.

Discount rates could also vary as a function of market interest rates. Chapter 4 shows that they do in other cases where a stream of future payments is converted to a lump sum. The EWG did not rule out this sort of adjustment.

Note that a mortality factor could be introduced into the lump sum calculation to account for the fact that younger retirees are less likely to draw their second career annuity until age 67 than are older retirees, although pre-67 mortality is low for military retirees. Lump sum calculations could take account of mortality differences, but do so through differences in the probability of receiving each future annuity payment rather than through differences in the discount rate.

4. **Use rates that are not seen as unfairly high.** This is an unavoidably subjective criterion with several possible interpretations. One interpretation is that any voluntary choice is not unfair. Retirees have the option of rejecting the lump sum. Those who choose to take it feel they are better off. Having a choice has helped them, even at a high GDR; this cannot be considered unfair. A second interpretation is that it would be unfair to military retirees to use a discount rate substantially higher than those used in similar circumstances by other retirement plans. The practices of other retirement plans will be discussed in Chapter 4. A third interpretation is that the discount rate should not be appreciably higher than interest rates for secure loans. In a sense, provision of the lump sum is like a very secure loan. The Service member is getting the money up front, like a loan, and paying for it by forgoing future annuity payments—fully assuring payment when the loan is taken out. Interest rates on secured loans, like home mortgages, curently have real interest rates below 2 percent.
5. **At worst, be cost neutral to the Military Retirement Fund (MRF).** The MRF receives funds as part of the retirement accrual process based on a factor calculated to fully fund retirement payments in the future. The idea of the lump sum option is to allow some retirees to receive their pensions in a more useful form; it is not meant to make military retirement more expensive to the government. The subject of government costs is addressed in Chapter 6.
6. **Not unduly affect retention.** The BRS was explicitly designed to meet the Services' goals for continuation behavior. It is possible that the availability of the lump sum option could both induce greater retention to 20 YOS (because the lump sum option makes the pension more attractive) and reduce retention past 20 (because in order to receive the lump sum you have to retire). The EWG deemed both of these to be undesirable, because they would make it harder for the Services to manage their force structures.

While the BRS will automatically cover personnel who enter the military after January 1, 2018, personnel with less than 12 YOS will have the option of moving into the

BRS. **It would be useful for individuals making a choice of whether to join the BRS to be fully informed about the discount rate they would face when making a lump sum decision at the point of retirement.** This implies consistency in the discount rate over time, which may conflict with, for example, market-driven variations in the discount rate.

3. Review of Literature on Personal Discount Rates

There is a considerable literature on the personal discount rates of individuals under a range of circumstances. We review this literature in general, but focus particularly on two studies of military personnel. A more detailed discussion of the literature is provided in Appendix A.

A. Warner and Pleeter 2001

The first study, by Warner and Pleeter,[3] focused on responses to choices offered in the downsizing program of the early 1990s. After the fall of the Berlin Wall in 1989, DoD was confronted with the problem of how to downsize the Active Duty force from about 1.9 million personnel to 1.5 million. DoD officials knew that, in order to avoid future imbalances in the YOS distribution of the force, the Department would need to reduce the force across the YOS spectrum and not just reduce new accessions. However, to reduce the mid-career (YOS 7–15) force without some form of separation payment would be seen by many as unfair and would hurt morale. After much negotiation between DoD and the Congress about how to construct a downsizing program, a system was implemented at the start of FY 1992 that offered eligible personnel in the YOS 7–15 interval who chose to separate, a choice between a lump sum separation benefit and an annuity. The annuity was called the Voluntary Separation Incentive (VSI) and the lump sum payment was called the Selective Separation Benefit (SSB). Monthly VSI payments were set equal to 2.5 percent of final monthly basic pay (BP) times YOS. Payments were to be received for a number of years equal to twice the member's YOS. The benefits were not indexed for inflation. The SSB alternative provided a lump sum payment of 15 percent of annual BP multiplied by the member's YOS (i.e., the equivalent of six years of VSI payments as a lump sum). (The SSB was thus equal to 1.5 times the payment received in the event of involuntary separation.)

Despite the fact that the SSB payment was not very generous, most separated personnel opted for the lump sum. Analysis showed that the average revealed PDR of officers was more than 10 percent and that of enlisted personnel was more than 30 percent.

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[3] John T. Warner and Saul Pleeter, "The Personal Discount Rate: Evidence from Military Downsizing Programs," *American Economic Review* 91, No. 1 (March 2001): 33–53, http://www.jstor.org/stable/2677897.

However, the circumstances of the Drawdown choice were quite unlike the circumstances under which people will make BRS lump sum decisions. First, the size of the payments was considerably smaller, and higher discount rates tend to be associated with smaller amounts. Second, unexpected involuntary separations were occurring at the same time for many, leaving individuals strapped for cash (which leads to temporarily high PDRs). Based on the findings of Warner and Pleeter, in our analysis we will generally refer to an average PDR of between 12 and 13 percent as Drawdown-like.

B. Simon, Warner, and Pleeter 2015

The second study, by Simon, Warner, and Pleeter,[4] analyzed the behavior of people offered a choice of retirement systems between 2001 and 2007. Individuals who had joined the military after 1986 were enrolled in a less generous retirement system known as REDUX. In 2000, the Congress allowed these people to choose whether to convert back to the traditional "High-3" retirement system or to stay in REDUX and receive a lump sum payment of $30,000, called the Career Status Bonus (CSB). Personnel had to make their choice during their fifteenth YOS. The authors found that the choices made indicated much lower PDRs than were found in Warner and Pleeter. The average real PDR for officers was found to be 4.3 percent, and that for enlisted personnel was 7.2 percent.[5] We refer to an average PDR of 5.7 percent as "REDUX-like." While one cannot be certain, we believe that the REDUX experience will best predict BRS lump sum behavior.[6]

The apparently high discount rates that separating personnel exhibited during the downsizing period might have been a result of special circumstances that induced them to opt for the SSB. One abnormal circumstance was the fact that the program was announced relatively suddenly in the fall of 1991, and personnel may not have been able to plan in advance for their departures from service. The suddenness of the program was compounded by the fact that the Drawdown occurred in the middle of a severe recession, with unemployment in excess of 8 percent. As a result of these circumstances, personnel departing from military service under the Drawdown program may have simply lacked the financial cushion to weather the transition from service or a long spell of unemployment.

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4 Curtis J. Simon, John T. Warner, and Saul Pleeter, "Discounting, Cognition, and Financial Awareness: New Evidence from a Change in the Military Retirement System," *Economic Inquiry* 53, No. 1 (January 2015): 318–34, doi: 10.1111/ecin.12146.

5 Throughout this paper, discount rates—both PDRs and GDRs—are presented in real terms, that is net of inflation, unless otherwise noted.

6 A third paper (based on the 2004 Status of Forces survey), John T Warner, *More Evidence on Personal Discount Rates of Military Personnel*, unpublished report prepared for the Defense Advisory Committee on Military Compensation (Clemson, SC: Clemson University, Department of Economics, August 5, 2005), confirms the findings of Simon, Warner, and Pleeter.

By contrast, the CSB/REDUX versus High-3 choice did not involve a simultaneous career change and was likely based more on lifetime income or utility maximization.

Additional, and perhaps more compelling, evidence that relevant PDRs are lower than those found in the Drawdown study is provided by the participation habits of individuals in the Federal Thrift Savings Plan (FTSP). Even with no matching funds from the government, 33 percent of enlisted personnel in the CSB/REDUX analysis database contributed to the FTSP, and their average contribution was more than 6 percent of base pay. More than half of officers contributed an average of 9 percent of base pay. Over the past 10 years, the average real rate of return to FTSP investments has been in the 3 percent to 5 percent range; personnel would likely not be making these investments if their PDRs were above that range. This implies that even the REDUX-based PDR estimates may be high.

4. Current Practices for Lump Sum Calculation

A. Loans and Annuities

Many situations in the general economy involve establishing equivalence between a future stream of payments and an immediate cash amount. The most familiar of these is a basic loan, in which a lender exchanges an immediate payment of $X for a future stream of return payments of $Y per period for N periods. The difference between X and N*Y reflects a combination of the interest rate[7] used by the lender, the fee charged for the service, and the lender's estimate of the probability that the customer will default on the loan. In the other direction, most insurance companies sell annuities, in which a customer can pay $X today in exchange for return payments of $Y per period, either for a fixed period or until the death of the customer. In this case, the value of X reflects a combination of the discount rate, the insurance company's fee, and a mortality table.

Because both loans and annuities are intended to turn a profit for the lender or insurer, the interest rates and fees associated with them are driven by the forces of supply and demand, the state of the economy,[8] companies' internal rate of return thresholds, and usury laws.

B. Lottery Winnings

For most (legal) lotteries, the advertised current value of the lottery jackpot is actually the total undiscounted value of a heritable[9] annuity—$Y per year over N years, in the notation of the previous section. Winners are generally offered the option to receive either

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[7] In financial transactions, the discount rate is generally referred to as an interest rate, and the two terms are used interchangeably.

[8] In particular, both lenders and annuitants set their interest rates based on the expected risk and return of their other investments. There is no point in lending money at 7 percent if extremely safe bonds are paying 8 percent; similarly there is no point in offering an annuity at 7 percent if the company's planned investments are expected to pay only 6 percent over the term of the annuity.

[9] An annuity is *heritable* if payments continue even should the beneficiary die during the term of the annuity. Any subsequent payments would be made to the designated heir(s) of the beneficiary. Most lottery annuities are heritable. No mortality tables are used in the calculation of the lump sum equivalent of a heritable annuity, because death does not change the amount the annuity will eventually pay. This is distinct from an annuity with a *survivor benefit,* in which a surviving spouse or other heir receives (typically reduced) payments for the remainder of the term of the annuity. Annuities with survivor benefits use special mortality tables that reflect the probability that both the original beneficiary and the spouse/heir will have died within a certain time period.

that annuity or a single lump sum payment of $X. The value of X is determined by the market; the lottery operator shops for an annuity that would pay $Y per year for N years, then allows the winner to receive either that annuity or its current price in the open market. The price of the annuity does not depend on the age or sex of the winner, because the award is heritable. As of 2016, lump sum payments for large multistate lotteries such as Powerball™ and MegaMillions™ reflected discount rates of less than 3 percent (nominal).

Another source of insight into an appropriate discount rate for converting lottery-like income streams to lump sums comes from the FTSP, which offers an annuity option for beneficiaries. Its conversion factor is based on an Annuity Interest Rate Index (AIRI) computed by the Federal Retirement Thrift Investment Board. That index is based on an 8-week moving average of 10-year interest rate swaps, updated monthly.[10] Recent (nominal) rates for the AIRI are shown in Figure 1. These rates are quite low by historical standards; for example, at the beginning of 2001, the AIRI stood at 6.0 percent. As with other market-indexed rates, recent values of the AIRI have even flirted with negative real interest rates, due to the unusual depression of bond markets relative to the overall economy.

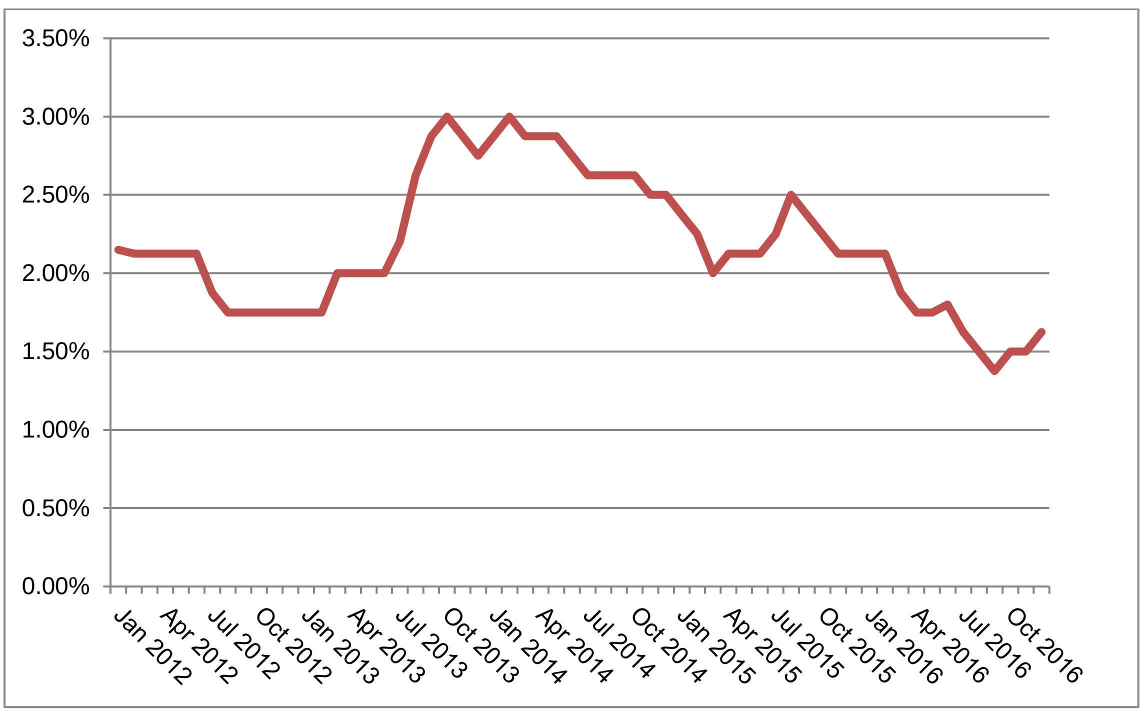

Figure 1. Annuity Interest Rate Index History 2012–2016 (Nominal)

[10] KPMG, LLP, *Performance Audit of the Thrift Savings Plan Annuity Process*, Employee Benefits Security Administration, November 30, 2015, accessed November 25, 2016, https://www.frtib.gov/pdf /minutes/MM-2016Jan-Att7.pdf.

C. Distributions from Retirement Plans

Defined benefit retirement plans also offer lump sum equivalent payments in some circumstances. The most common cases are plans that offer new retirees a one-time choice between an annuity and a lump sum, and plans that offer surviving spouses and/or dependents a one-time choice between their survivor benefit and a lump sum.

For private single-employer defined benefit plans, the calculation of lump sum equivalents is determined by statute. Section 417(e)(3) of the Internal Revenue Code (IRC)[11] specifies both the discount rate and mortality tables to be used. Since 2006, that discount rate is determined as a composite of three high-quality corporate bond yield curves, with different rates applying to different time horizons. These three rates, known as "segment rates," are updated monthly by the Internal Revenue Service and published in the Federal Register. A significant feature of this approach is that the discount rate used for lump sum payment calculations varies with the age of the recipient, even for fixed-term annuities. Shorter-term annuities use lower discount rates, reflecting the generally lower yields of short-term investments. Figure 2 shows the Section 417(e)(3) effective discount rate for an annuity running through age 67, as a function of the age of the beneficiary, as of August 2016.

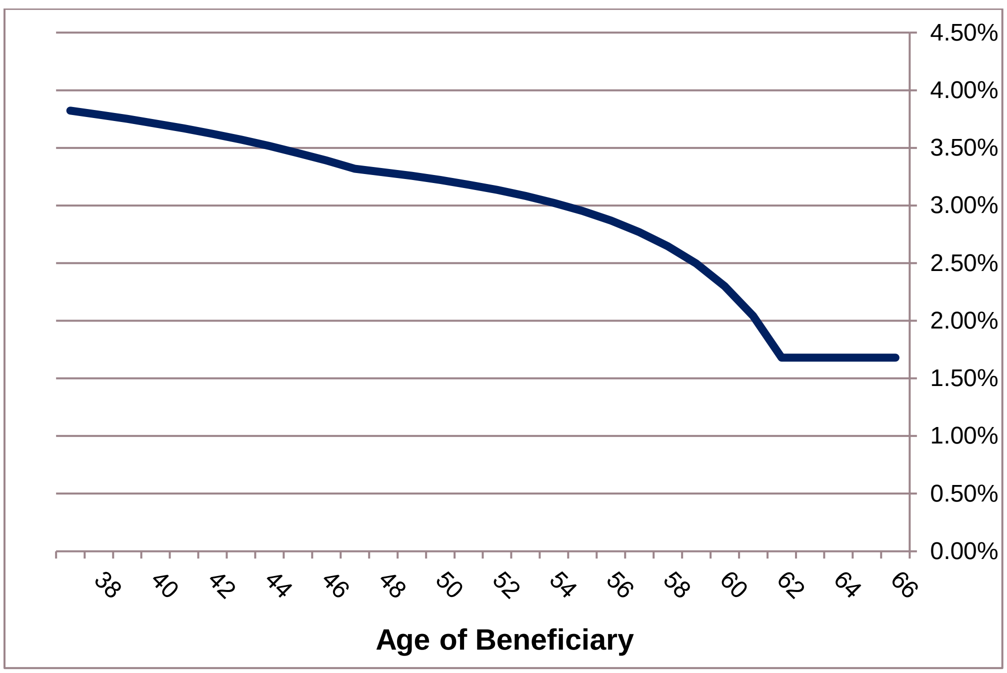

Figure 2. Effective Nominal Discount Rate by Age under Section 417 Rules

[11] 26 U.S.C. 417.

For public sector retirement plans, there is no corresponding statutory requirement to use specific discount rates. The usual practice is for the plan to estimate its expected future growth rate over some reference time horizon (closely related to the rate of return it expects on its investments), and to combine that expected growth rate with actuarial assumptions regarding beneficiaries to calculate a discount rate that is actuarially neutral for lump sum equivalents. This means that (on average) the expected future value of the fund will be unaffected by individual decisions to accept or decline the lump sum alternative, which simplifies bookkeeping. Because the same discount rate is used for all calculations, regardless of the age of the beneficiary, this approach is somewhat more generous for older beneficiaries than a yield curve approach would be—in effect, everyone gets the long-term rate.

Federal retirement plans tend to invest in US government bonds, which have relatively low expected rates of return. For example, the DoD MRF currently invests primarily in Treasury Inflation Protected Securities held to maturity. As of 2016, the estimated long-term growth rate for the MRF was 2.5 percent in constant dollar terms, 5.25 percent in nominal dollar terms.[12]

State and local retirement plans tend to invest more aggressively in a mix of stocks, corporate bonds, and government bonds. This gives them a higher expected rate of return (with correspondingly higher investment risk). As a result, state and local plans tend to use higher discount rates than federal plans, with correspondingly smaller lump sum payments. Figure 3 shows the recent history of growth rate assumptions used by the 127 members of the National Association of State Retirement Administrators (NASRA).[13] In 2015, the average assumed growth rate among NASRA members was 7.62 percent (nominal), with nearly all funds falling in the 7 percent to 8 percent range. Adjusting for various current inflation forecasts, this corresponds to real discount rates in the 4.5 percent to 6 percent range.

[12] The guidelines used by the DoD Actuarial Board for forecasting growth rate and inflation are specified in Federal Accounting Standards Advisory Board, *Statement of Federal Financial Accounting Standards (SFFAS) 33*, October 14, 2008, http://files.fasab.gov/pdffiles/handbook_sffas_33.pdf. These standards specify, for example, that discount rates should be based on interest rates of marketable securities of similar maturities to the flows of payments being made, and that they should reflect historical averages over a period of at least five years. The MRF uses a 100-year planning horizon for both growth rate and inflation estimates.

[13] Chart from Figure 4, "Change in Distribution of Public Pension Investment Return Assumptions, FY 01 to FY 18," in *NASRA Issue Brief: Public Pension Plan Investment Return Assumptions*, February 2017, http://www.nasra.org/files/Issue%20Briefs/NASRAInvReturnAssumptBrief.pdf.

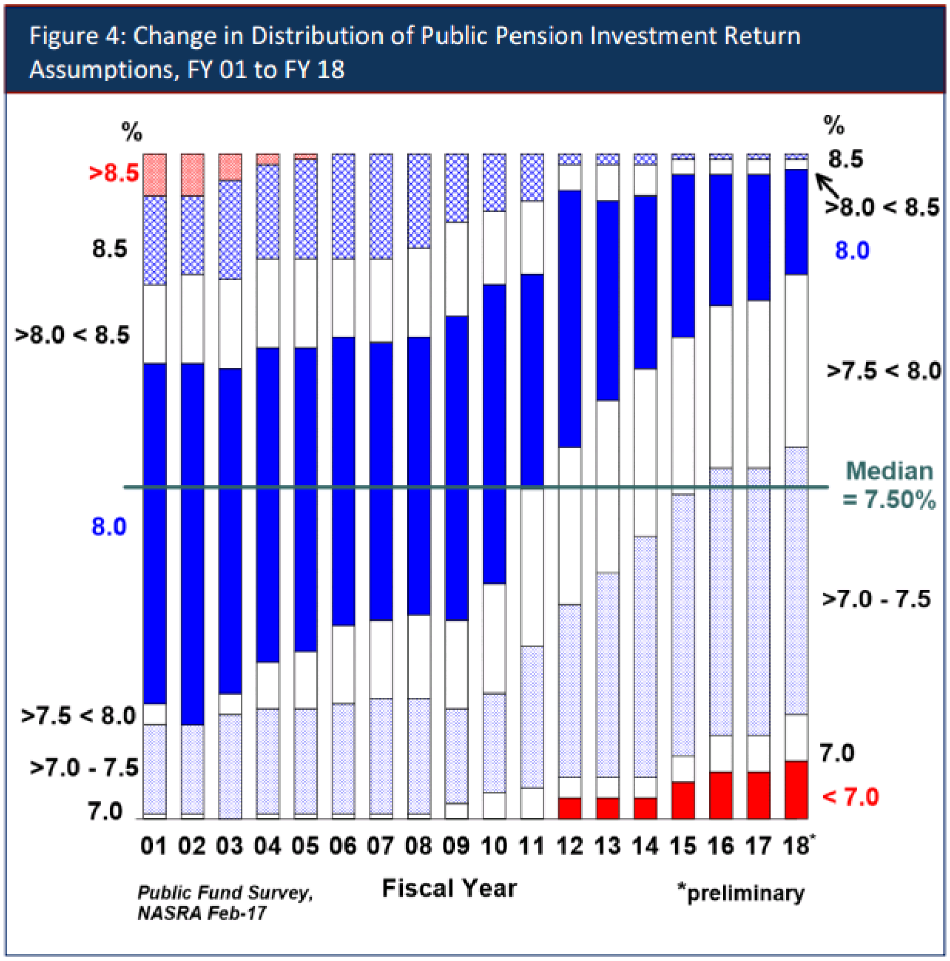

Figure 3. Trend in State Pension Fund Nominal Growth Rate Assumptions

D. Implications for Selection of the GDR

DoD could be consistent with existing behavior by choosing a discount rate based on conditions in private market transactions, as lotteries do, but currently this would imply using a rate below the expected return on investments in the MRF. Such a choice would violate the guiding principle that the offering of the lump sum not make military retirement more expensive to DoD.

The same is true for following the rules specified by the IRC for private retirement plans.

As noted, the MRF currently forecasts long-term real investment growth of 2.5 percent. Figure 4 illustrates the effect of different discount rates on the MRF. Consider a hypothetical annuity of $100 to be paid with certainty (i.e., no mortality) in each of 10 years. Military retirement pay is fully indexed to inflation, so the $100 can be viewed as a real (inflation-adjusted) payment. With DoD applying a real discount rate of 2.5 percent, the discounted cost of that stream of payments is represented by the green line; for example, the discounted cost of the tenth payment is $80. The total discounted cost is the area under the green line (actually, the area of the trapezoid bounded above by the green line and below by the horizontal axis, and on the left and right by the coordinates of year 1 and year 10). That value, $897, is also represented by the tall green bar on the right of the figure. A lump-sum payment of $897 has a neutral effect on the MRF as compared to the stream of $100 over 10 years. At a lower, market-determined real discount rate of, say, 1.0 percent, the discounted payments are higher and the lump-sum payment totals $957 (the area under the brown line, or the height of the taller brown bar). The extra $60 when the lump sum is calculated at a lower, market rate represents a net loss to the MRF.

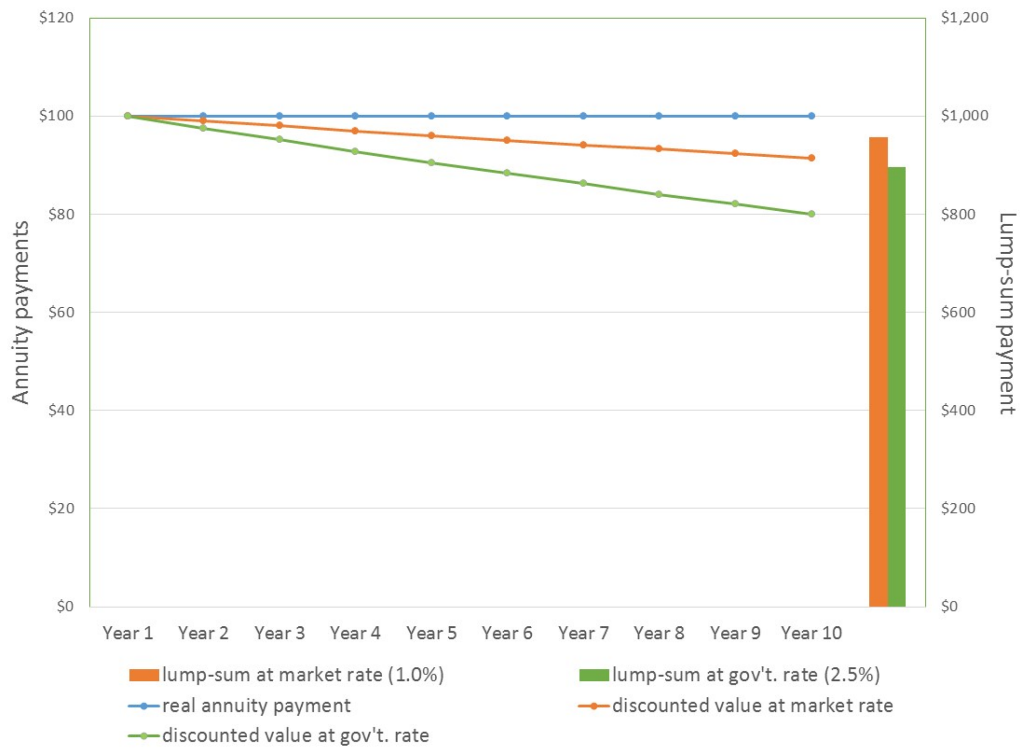

Figure 4. Federal Government Cost of Lump-Sum Payout at Two Different Real Discount Rates

However, when mortality is considered, choosing a discount rate of 2.5 percent would result in an expected net loss to the MRF, because not all retirees live to age 67. To compute a break-even discount rate, the DoD Actuary would need to estimate the effect of mortality on expected future annuity outlays, and adjust the present value of those annuities accordingly. This adjustment would have two parts. First, mortality tables and an estimate of the age distribution of retiring cohorts could be used to estimate the effects of natural mortality. Second, there is a potential adverse selection effect, in which retirees in poor health (or who otherwise expect not to live until age 67) would have a stronger incentive to opt for the lump sum, whatever their PDRs. Preliminary analysis by the DoD Actuary estimates that the combined effect of accounting for both mortality and adverse selection would lower lump sum amounts by somewhere between 2 percent and 4 percent. If DoD were to assume a combined mortality/selection effect of 3 percent and an annuity duration of 23 years, this would result in a breakeven discount rate of just under 2.8 percent.

Mirroring state pension fund behavior would imply using a higher real discount rate.

NDAA 2016 specifies that the lump sum shall be computed using average PDRs of military personnel. The most literal reading of this language would make the choice of GDR independent of market practice.

Existing approaches to calculating lump sum equivalents to a stream of subsequent payments all adjust the payment in response to changing market conditions. When real interest rates in the market rise, lump sum payments (and, thus, take rates) fall. If DoD adopts a market-based adjustment strategy, it could be seen as unfairly treating some cohorts of retirees better than others. This is an issue that will have to be considered in determining discount rate policy unless it is decided to base the discount rate solely on an unchanging expectation about the PDR distribution of military personnel.

5. Estimated Lump Sum Take Rates

We predicted the take rates and retirement costs of a cohort of new military retirees confronted with a range of lump sum options. This cohort of 48,633 retirees includes non-disability Active Duty retirees and Reservists. The data exclude disability retirees, who are not eligible for the lump sum option. However, the data include non-disability retirees from Active Duty who are eligible for receipt of disability compensation from the Department of Veterans Affairs (VA). The regulations surrounding disability compensation introduce complications that we took into account in the following analysis.

Analysis proceeded through the following steps for each individual in the cohort:

1. Compute DoD retirement liabilities under the BRS without the lump sum option. This involves taking account of possible mortality before age 67 and calculating the real expected present value of cost to the government at retirement of future payments, applying the real discount rate used by the DoD Actuary (2.5 percent).

2. Compute DoD retirement liabilities with the lump sum option. For simplicity we assume a 50 percent lump sum cash-out[14] and compute the size of the lump sum under a range of GDRs ranging from 2.5 percent to 20.5 percent. The present value of the cost to DoD is the lump sum plus half the present value computed in Step 1.

3. Account for differential taxation of the retirement annuity and the lump sum amount and also VA-offset effects. The lump sums can be considerable, often over $300,000 for officers. Receipt of the lump sum can push individuals into higher tax brackets. We modeled the family income of individuals based on their personal characteristics and estimated the impact of differential tax rates on the net size of the lump sum payments.

   In addition, military retirees may be eligible for monthly disability compensation payments from the VA. Veterans must apply for a VA disability rating and undergo a medical exam to establish whether their disabilities are service-connected in order to receive VA disability payments. These exams determine the number of medical conditions that are service-connected and the degree of disability associated with each condition. After an exam, the veteran

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[14] This may lead us to overstate the amount of lump sum payments made.

receives a Combined Disability Rating (CDR) that ranges from 0 percent disabled to 100 percent in 10 percent increments; tax-free monthly payments range from $133 for a 10 percent disability to over $3,200 per month for a 100 percent disability. VA disability compensation is relevant to our analysis because military retirees who receive a CDR ranging from 10 percent to 40 percent experience a dollar-for-dollar offset of military retirement pay for the disability compensation received. For retirees subject to offsets, VA disability payments do not change gross income but they increase after-tax income because VA benefits are not federally taxed. VA offsets will not apply only to monthly retirement payments, but to lump sum amounts as well. The BRS legislation explicitly states that "compensation benefits payable to a person under this title shall be reduced by the amount of any lump sum payment made to such person under section 1415 of title 10." This means that VA disability compensation payments will not be made to a retiree who exercises the lump sum option until the future point at which the amount of VA compensation payments the individual would have received based on his or her CDR begns to exceed the amount of the lump sum payment. This substantially reduces the value of the lump sum payment to many retirees. We estimate that 32 percent of retirees will be subject to VA offsets. Our calculation of the net size of the lump sum to individuals takes this probability into account.

4. Estimate lump sum take rates. For every GDR modeled (from 2.5 percent to 20.5 percent), we calculate the net size of the lump sum for each individual in the cohort. Whether an individual takes the lump sum depends on his or her PDR. For a given distribution of PDRs, we randomly select a PDR for each retiree. An individual will take the lump sum if the present value of that choice, using his or her PDR, is greater than the present value of receiving his or her full second-career annuity. We did the analysis for four PDR distributions.

Figure 5 shows the estimated take rates for the entire range of GDRs under the highest (Drawdown-like) and lowest (REDUX-like) discount-rate scenarios.

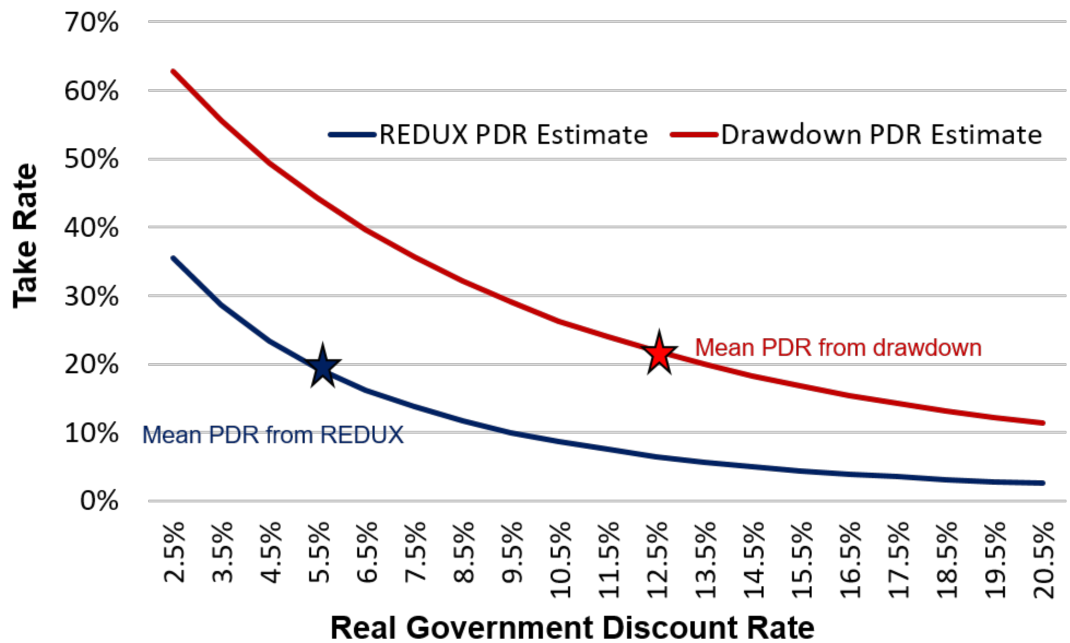

Figure 5. Lump Sum Take Rates as a Function of Real Government Discount Rate

Under the REDUX-like PDR secenario, which we deem most relevant, the expected take rate is under 40 percent even at low GDRs, and is 19 percent when the GDR is set equal to the 6.5-percent mean of the PDR distribution. Under the Drawdown-like scenario the expected take rate is above 50 percent at low discount rates, is 42 percent at a GDR of 6.5 percent, and falls to 22 percent at a GDR of 12.5 percent, which equals the mean PDR for that scenario. The take rate declines rapidly as the GDR increases and the size of the lump sum correspondingly decreases.

Appendix B through Appendix F present the take-rate analysis in greater detail.

6. DoD Cost Savings

In Step 2 of the lump sum analysis on page 21, we calculated the cost implications for DoD at various GDRs. As the GDR rises, the value of the lump sum—and thus the cost to the government—falls for every individual who chooses the lump sum. However, also as the GDR rises, fewer people choose the lump sum because of its lower value. Figure 6 shows the interaction of these two factors. Savings are measured by the expected reduction in the lifetime cost to the government of retirement payments received by individuals who retired in FY 2015.[15]

In a REDUX-like PDR scenario, the present value of government savings rises to $400 million relative to a no lump sum case at a GDR of 6.5 percent. In a Drawdown-like PDR scenario, they rise to $1.05 billion at a GDR of 8.5 percent. Raising the GDR above these levels leads both to reduced government savings and reduced generosity to retirees choosing the lump sum.

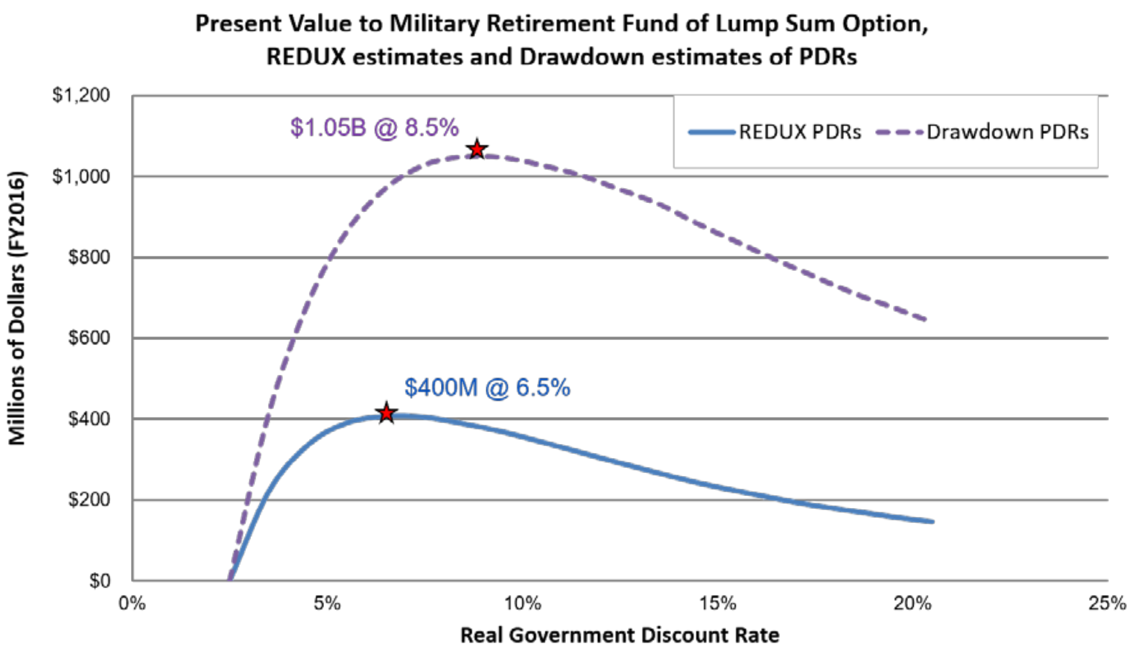

Figure 6. Government Savings as a Function of Real Government Discount Rate

15 A 2.5 percent discount rate (reflecting the expected return on funds in the MRF) is used to convert future payments to present value. Mortality effects are not considered in the calculation.

7. Placing the Discount Rate in Context

Figure 7 summarizes the much of the discussion of the previous five chapters.

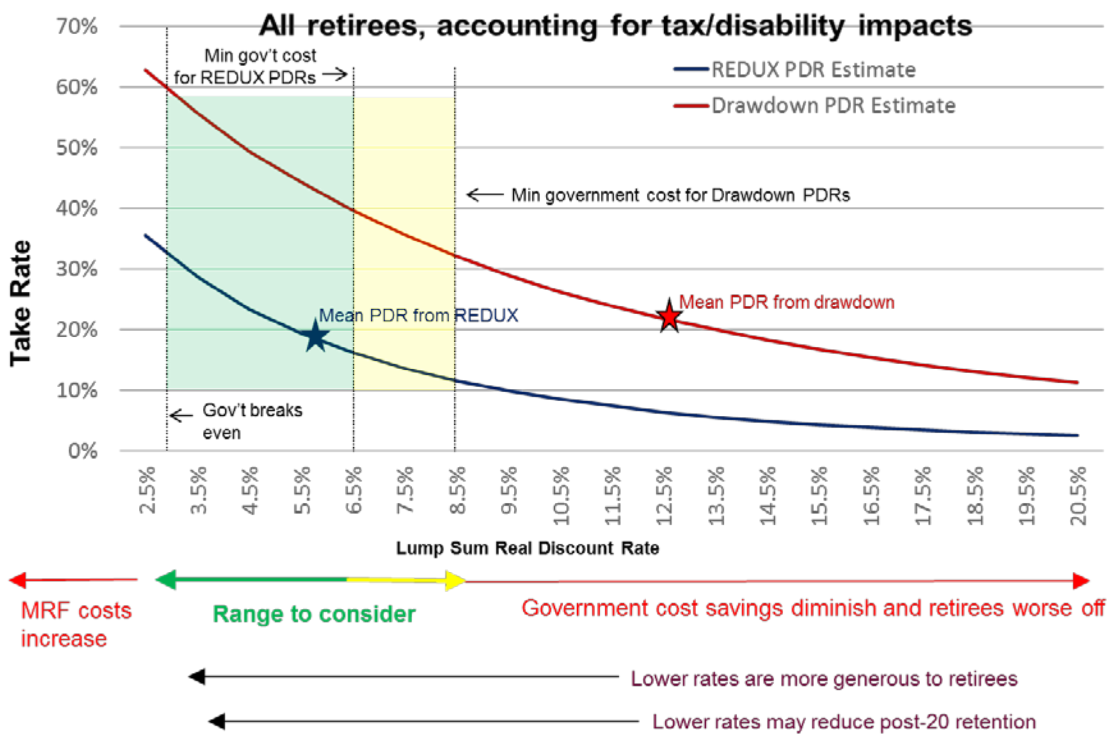

Figure 7. Characteristics of Discount Rate Choices

The blue curve depicts the expected lump sum take rate if the PDR distribution is like the one estimated in analysis of REDUX behavior. It varies with the real GDR, from 36 percent at a GDR of 2.5 percent to 2 percent at a GDR of 20.5 percent. The red curve depicts the higher take rates that would be expected if the PDR distribution is like the one estimated in the analysis of Drawdown behavior.

Chapter 6 showed that government savings due to the availability of a lump sum option falls for GDRs greater than 8.5 percent if the Drawdown PDR distribution pertains. Thus, for higher GDRs, both the government and retirees selecting the lump sum are financially worse off. If the REDUX PDR distribution pertains, both the government and retirees are financially worse off when GDRs rise above 6.5 percent.

Since the MRF is expected to yield real returns of 2.5 percent, use of a GDR below that would reduce the ability of the MRF to cover future retirement annuity payments.

Because of mortality (as discussed in Chapter 5), and the choice of the lump sum by a small number of retirees who would have received VA disability payments and forgone some retirement benefits without the lump sum option, MRF costs would increase for GDRs below roughly 2.8 percent.

Thus, based on the discussion so far, if the PDR distribution of retirees is like the one underlying REDUX choices, the GDR should be in the range of 2.8 percent to 6.5 percent—the green area in Figure 8. If the PDR distribution is like the one underlying Drawdown choices, the GDR should be in the range of 2.8 percent to 8.5 percent—the green area plus the yellow area in Figure 7.

Figure 8 includes one additional element, comparison of possible GDRs to other rates that could be used as benchmarks (measured along the horizontal axis), discussed in Chapters 3 through 5.

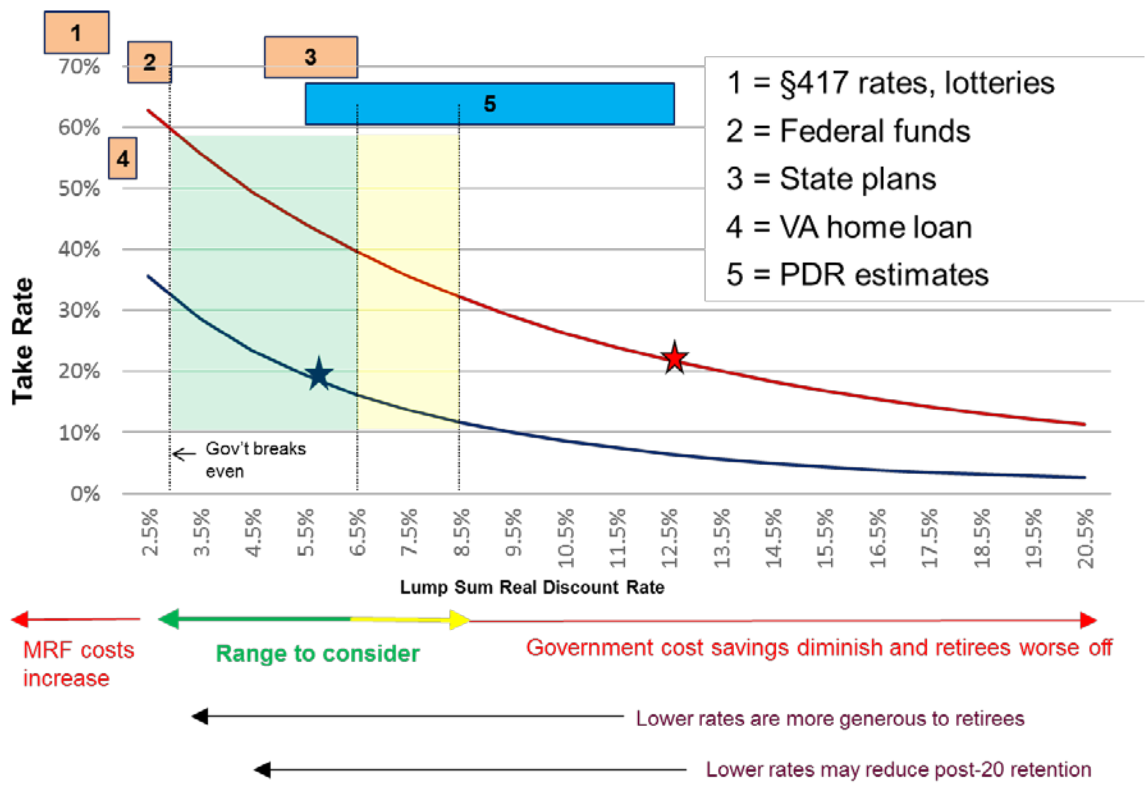

Figure 8. Implications of Possible Benchmark Discount Rates

At the current time, discount or interest rates associated with private retirement plans (via IRC Section 417), federal retirement plans, lotteries, and secure VA home loans are all too low to meet the criterion that the GDR should at worst be cost neutral to the MRF. Discount rates used by state retirement plans fall in the green area in Figure 8. The low end of the range of average PDR estimates falls in the green area, but much of the average PDR falls outside of the shaded areas, where both the government and retirees are financially worse off than they would be at lower GDRs.

The retention implications of various GDRs have not yet been discussed. It might be that the criterion of not unduly affecting retention would be violated at lower rates (and higher lump sum payments) if they would induce too many personnel to leave the Services shortly after reaching retirement eligibility. Chapter 8 addresses this possibility.

8. Effect of the Lump Sum Option on Retention

It is important to know how sensitive retention will be to the DoD discount rate. The lower the DoD discount rate, the more effect the lump sum option will have on retention patterns. This is because the lump sum payments will be bigger, and hence be more attractive at lower GDRs. The analytical question, then, is whether the lump sum option will pull significantly more personnel to the 20-year retirement vesting point because of the availability of immediate, sizeable cash payments and whether the availability of such payments will push more personnel out shortly after they reach that point.

We analyzed these issues using a modified version of the Dynamic Retention Model (DRM) developed by the RAND Corporation. The DRM operates by examining individuals' incentives at every retention decision point. The choice is driven by whether the expected return on staying is greater than the expected return on leaving over the entire future. The model incorporates not only pecuniary benefits but also a taste for service that is drawn from a distribution calibrated to correspond well to observed retention behavior.

Use of the DRM has always required that a PDR be used to value future compensation, including retirement benefits. Prior practice has been to use the same PDR for everyone. This is not suitable for analysis of the lump sum option in the BRS. We modified the model to incorporate hypothesized PDR distributions of the kinds used in our take-rate analysis.

We calibrated the model based on the annual continuation behavior of Service members between FY 2001 and FY 2009 for enlisted personnel and between FY 2008 and FY 2009 for officers. We then used the model to simulate the continuation behavior of hypothetical entering cohorts under various GDR choices and assumed PDR distributions.

Table 1 shows the results of our analysis for three possible PDR distributions, ranging from a REDUX-like (low) PDR scenario to a Drawdown-like (high) PDR scenario.

Table 1. Continuation Implications of Lump Sum Option

Years of Service	GDR	REDUX-like PDR Scenario				Intermediate PDR Scenario				Drawdown-like PDR Scenario			
	GDR	No LS (base rate)	2.5% (change)	5% (change)	7.5% (change)	No LS (base rate)	2.5% (change)	5% (change)	7.5% (change)	No LS (base rate)	2.5% (change)	5% (change)	7.5% (change)
	Enlisted Personnel												
	5	52.8	0.1	0	0	54.5	0.1	0	0	55.5	0.1	0	0
	10	21.6	0.3	0.1	0	23.7	0.2	0.1	0	24.8	0.2	0.1	0
	15	14.2	0.4	0.2	0.1	15	0.4	0.2	0.1	15.3	0.4	0.2	0.1
	20	12	0.5	0.2	0.1	12.5	0.6	0.3	0.2	12.5	0.6	0.3	0.1
	25	2.8	-0.2	-0.1	0	2.9	-0.3	-0.2	-0.1	2.8	-0.5	-0.3	-0.2
	30	0.9	-0.1	0	0	0.9	-0.1	-0.1	-0.1	0.9	-0.2	-0.1	-0.1
	Officers												
	5	82.2	0.1	0	0	82.3	0.1	0	0	82.5	0.1	0	0
	10	51.4	0.3	0.1	0	49.8	0.5	0.2	0	49.1	0.6	0.3	0.1
	15	39	0.3	0.1	0	36.4	0.7	0.3	0.1	34.7	0.9	0.5	0.1
	20	32.9	0.3	0.1	0	29.9	0.8	0.4	0.1	27.9	1.1	0.6	0.2
	25	12.1	-0.4	-0.2	-0.1	9.2	-1.2	-0.7	-0.3	7.6	-1.8	-1.2	-0.6
	30	3.7	-0.1	-0.1	0	2.4	-0.3	-0.2	-0.1	1.9	-0.5	-0.3	-0.2

The table shows the fraction of an entering cohort that is expected to remain after various lengths of service. Individuals who have chosen to remain after 20 years do so after qualifying for their retirement annuities. The first column for each PDR scenario shows expected retention behavior under the BRS with no lump sum (LS) option.[16] The other columns show how much we expect retention to be affected (relative to the no-lump sum case) by the availability of the lump sum in each PDR scenario for a range of GDRs. These estimates assume that personnel are fully informed about tax effects and VA offset effects and account for them at every decision point. DoD is planning classes to provide such information. Our team has examined the effectiveness of such classes. Based on a review of the relevant literature, we found that, to be effective, great care must be taken to ensure that the material presented is specifically tailored to individuals.[17]

In the REDUX-like scenario, continuation beyond year 20 is only expected to rise by 0.5 percentage points for enlisted personnel and 0.3 percentage points for officers, even with a very low GDR. Continuation beyond year 25 is expected to fall by a similar or smaller amount. Under a Drawdown-like PDR scenario, however, they would be more substantial. If lump sums were calculated using a 2.5 percent GDR, the reduced enlisted continuation through year 25 would fall 0.5 percentage points; for officers the decrease would be 1.8 percentage points. This amounts to 18 percent fewer enlisted personnel and 25 percent fewer officers remaining in service that long. Calculating lump sums using a

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16 The no-lump sum numbers differ across the scenarios because the model was calibrated using the REDUX-like PDR distribution. It was not recalibrated for analysis of the Drawdown-like case. When individuals have higher PDRs their retention choices will be slightly different. In any event, our interest is in examining how the availability of the lump sum option affects continuation.

17 Susan L. Rose and John E. Morrison, “Effective Financial Decision Aids,” IDA Document D-8214 (Alexandria, VA: Institute for Defense Analyses, July 2017).

7.5 percent GDR would show an impact roughly one-third as large. Thus, the impact of the lump sum option on post-25 YOS retention would be fairly small if PDRs are REDUX-like (which seems most likely), but could be more than modest for long-term careers under a Drawdown-like PDR scenario.

The availability of the lump sum tends to induce more personnel to remain in until 20 YOS and to induce more to leave by 25 YOS. A useful statistic that summarizes retention and survival under a given compensation regime is person-years per accession (PYPA). This statistic simply indicates how many years an entrant is expected to remain in service under that regime. Based on the historical data used for the model calibrations, PYPA is 6.58 for enlisted personnel and 11.84 for officers (as shown in Table G-12). The lump sum option has very minor effects on PYPA. While the difference between PYPA with and without the lump sum option grows as the GDR decreases, the differences are never larger than 0.1 person-years. If DoD were to use a 7.5 percent discount rate to construct the lump sum payments, PYPA is barely changed from what it would have been without the lump sum option.

A more detailed discussion of our retention analysis is presented in Appendix G through Appendix J.

9. Determination of the Government Discount Rate

DoD decided to use a real GDR indexed by a seven-year average of high-quality corporate bonds plus an additional amount of roughly 4 percent. The rate will be adjusted annually to reflect changes in bond yields. This methodology yields an initial rate of 6.99 percent. Here we consider that decision in the context of the EWG guiding principles and IDA's analysis. Addressing the principles one at a time:

1. **Be consistent with the law**. That is, base the discount rate on the average PDR of military personnel. The Drawdown experience implies an average PDR of roughly 12.2 percent. The probably more relevant REDUX experience implies an average PDR of roughly 5.7 percent. A rate of 6.99 percent is between these bounds.
2. **Provide choice but do not appear to advocate for a particular choice**. At the selected GDR, we can expect a lump sum take rate between 15 and 40 percent. A 6.99 percent rate allows for choice.
3. **Be the same or vary for acceptable reasons**. The link to seven-year corporate bond rates ties the value of the lump sum to prevailing economic conditions. Tying the rate to a market index is common practice in both private markets and other government pension plans. It will be different for different retiring cohorts, but in a way that does not unfairly discriminate.
4. **Use rates that are not seen as unfairly high**. There are many possible definitions of fairness. Since no retiree is compelled to choose a lump sum, one could conclude that fairness is not an issue. The American Academy of Actuaries (AAA) noted, however, that,

    > When lump sum payments are offered in exchange for a promised pension benefit, the Internal Revenue Code requires private pension plans to use discount rates specified through regulation that are based on high-quality corporate bond yields.… The use of a higher personal discount rate produces a smaller lump sum and results in a lump sum

> amount that is not consistent with the value placed on the original annuity promised by financial markets.[18]

Consistent with the recommendation of the AAA letter, DoD is providing extensive educational material so that personnel will understand the implications of choosing the lump sum.

5. **At worst, be cost neutral to the MRF**. This criterion is met.
6. **Do not unduly affect retention**. The selection of a rate near 7 percent reduces the estimated impact on post-20 YOS retention relative to lower rates. We estimated the marginal attrition increase at 25 YOS, given the proposed 7 percent GDR, to be roughly 0.5 percentage points relative to the no lump sum case for officers and 0.2 percentage points for enlisted personnel if Drawdown PDR assumptions pertain. Under a REDUX-like PDR scenario, this would fall to 0.1 percentage points for officers; there would be no effect on enlisted retention.

The selected discount rate methodology makes use of IDA's analysis. It is consistent with congressional direction regarding how to select a GDR, and poses low risk to career retention levels. It is consistent with a belief that giving retirees additional voluntary choices cannot be unfair.

[18] Letter from William R. Hallmark, Chairperson, Pension Practice Council, American Academy of Actuaries to Todd Weiler, ASD(M&RA), April 27, 2016.

Appendix A.
Technical Analysis – Review of the Literature on Personal Discount Rates

An individual's Personal Discount Rate (PDR) is the rate that makes the individual indifferent between a given amount of money today and a different amount at some time in the future. If, for example, an individual is indifferent between $100 today and $110 one year from now, that individual is said to have a PDR of 0.1 or 10 percent. An individual who requires $120 a year from now to forgo $100 today has a PDR of 0.2 or 20 percent. Because the latter individual requires a larger amount in the future than the former individual in order to forgo $100 today, the latter individual is said to be more *impatient*. PDRs thus measure individuals' rates of impatience for money today over money in the future.

The purpose of this appendix is to review the economic literature on PDRs—those of military personnel in particular—in order to identify those "applicable and reputable studies." We focus most heavily on two natural experiments that enabled empirical estimates of the PDRs of some military personnel. We then provide additional evidence about military PDRs that is based on the August 2004 Status of Forces (SOF) survey of Active Duty members conducted by the Defense Manpower Data Center (DMDC). We also summarize findings about PDRs from non-military studies. Finally, the literature on PDRs is related to the recent and rapidly expanding literature on financial literacy and how people make financial decisions. We thus provide an overview of the findings from the financial literacy literature and its relationship to the literature on PDRs. This discussion will be useful to the Department of Defense as it develops a financial literacy and planning program for military personnel.

A. Overview and Caveats

PDRs are not observable quantities like product prices. Rather, they must be inferred from the choices that individuals make involving costs and benefits over time (intertemporal decisions). In one of the earliest studies of PDRs, Hausman estimated PDRs by how much more people were willing to pay for energy-saving appliances that reduce future electricity bills.[19] Since Hausman's study, economists and psychologists have

[19] Jerry A. Hausman, "Individual Discount Rates and the Purchase and Utilization of Energy Using Durables," *Bell Journal of Economics* 10, No. 1 (Spring 1979): 33–54, doi: 10.2307/3003318.

studied choices involving time in a variety of contexts and have obtained a wide range of estimates of individuals' willingness to trade dollars today for dollars in the future. The standard economic model described in the next section serves as the point of departure for analysis of intertemporal decisions and gives a precise theoretical answer as to what constitutes a PDR. Psychologists and other researchers tend to take a more agnostic view of what constitutes a PDR, and some even question its existence. Without committing to a particular theoretical viewpoint about what constitutes a PDR, we will take the practical approach of thinking of PDRs as measures of indifference between dollars now and dollars in the future that are implied by the choices that people make at a particular time when they are in a specific set of circumstances. We do not consider an individual's PDR to be invariant.

There have been over 40 empirical studies of PDRs based on intertemporal choices made in a variety of settings. These studies have produced a wide range of estimates of PDRs and found that they vary with a number of factors. Key among them are the demographic and socio-economic characteristics of the decision makers, the time horizons of the choices, the dollar amounts involved, and how the choices are framed. Generally speaking, studies have found PDRs to decline with age and with measures of socio-economic status such as education level and income. They have also been found to be lower for whites than non-whites, and they have been found to decline with the time horizon of the decision and with the magnitude of the amounts involved. It is apparent from the literature that, even after accounting for a wide range of observable determinants of PDRs, there is considerable variation in PDRs due to unobservable or inherently unmeasurable factors. As discussed in more detail below, sources of unobservable variation include such factors as limits on borrowing (liquidity constraints), lack of understanding or education about time discounting, cultural upbringing, and habits acquired during childhood.

Our literature review indicates that the non-military literature will provide little guidance as to the discount rates that future retirees will apply to—or reveal by—the lump sum cash-out decisions that they will make under the Blended Retirement System (BRS). The primary reason for this is that the amounts involved in these studies were uniformly smaller than the amounts involved in the three studies based on intertemporal choices military personnel did in fact make or said they would make. The estimates of the PDRs of military personnel found in the studies reviewed below are in fact generally much lower than PDR estimates found in the non-military studies. Furthermore, the military studies are also more useful because they permit estimation of the whole distribution of PDRs in the population of decision makers, whereas the non-military studies typically only report estimates of central tendency (i.e., average or median PDR). Frederick, Loewenstein, and O'Donoghue provide a comprehensive survey of the economic literature on intertemporal choices and time-discounting, summarized in Table A-1.

Table A-1. Empirical Estimates of Discount Rates

EMPIRICAL ESTIMATES OF DISCOUNT RATES

Study	Type	Good(s)	Real or Hypo?	Elicitation Method
Maital & Maital 1978	experimental	money & coupons	hypo.	choice
Hausman 1979	field	money	real	choice
Gateley 1980	field	money	real	choice
Thaler 1981	experimental	money	hypo.	matching
Ainslie & Haendel 1983	experimental	money	real	matching
Houston 1983	experimental	money	hypo.	other
Loewenstein 1987	experimental	money & pain	hypo.	pricing
Moore and Viscusi 1988	field	life years	real	choice
Benzion et al. 1989	experimental	money	hypo.	matching
Viscusi & Moore 1989	field	life years	real	choice
Moore & Viscusi 1990a	field	life years	real	choice
Moore & Viscusi 1990b	field	life years	real	choice
Shelley 1993	experimental	money	hypo.	matching
Redelmeier & Heller 1993	experimental	health	hypo.	rating
Cairns 1994	experimental	money	hypo.	choice
Shelley 1994	experimental	money	hypo.	rating
Chapman & Elstein 1995	experimental	money & health	hypo.	matching
Dolan & Gudex 1995	experimental	health	hypo.	other
Dreyfus and Viscusi 1995	field	life years	real	choice
Kirby & Marakovic 1995	experimental	money	real	matching
Chapman 1996	experimental	money & health	hypo.	matching
Kirby & Marakovic 1996	experimental	money	real	choice
Pender 1996	experimental	rice	real	choice
Wahlund & Gunnarson 1996	experimental	money	hypo.	matching
Cairns & van der Pol 1997	experimental	money	hypo.	matching
Green, Myerson & McFadden 1997	experimental	money	hypo.	choice
Johanneson & Johansson 1997	experimental	life years	hypo.	pricing
Kirby 1997	experimental	money	real	pricing
Madden et al. 1997	experimental	money & heroin	hypo.	choice
Chapman & Winquist 1998	experimental	money	hypo.	matching
Holden, Shiferaw & Wik 1998	experimental	money & corn	real	matching
Cairns & van der Pol 1999	experimental	health	hypo.	matching
Chapman, Nelson & Hier 1999	experimental	money & health	hypo.	choice
Coller & Williams 1999	experimental	money	real	choice
Kirby, Petry & Bickel 1999	experimental	money	real	choice
van der Pol & Cairns 1999	experimental	health	hypo.	choice
Chesson & Viscusi 2000	experimental	money	hypo.	matching
Ganiats et al. 2000	experimental	health	hypo.	choice
Hesketh 2000	experimental	money	hypo.	choice
van der Pol & Cairns 2001	experimental	health	hypo.	choice
Warner & Pleeter 2001	field	money	real	choice
Harrison, Lau & Williams 2002	experimental	money	real	choice

Source: Shane Frederick, George Loewenstein, and Ted O'Donoghue, "Time Discounting and Time Preference: A Critical Review," *Journal of Economic Literature* 40, No. 2 (June 2002):351–401.

B. Personal Discount Rates in Theory

In standard economic theory, a PDR—symbolized below by d—is derived from a model of choices about consumption, borrowing, and saving over time. In this model, a rational, fully informed individual will choose the amounts of consumption, borrowing, and saving that maximizes his or her lifetime utility. The maximization takes into account the individual's preferences for current versus future consumption, previously accumulated wealth, income in the current time period and each future time period, and the market interest rate at which the individual can borrow or lend. The model shows that an individual with a PDR equal to d will always be willing to trade \$*X* now for $\$X(1+d)^t$ years from now, and vice versa. For example, if $d = 0.1$, the individual would require 10 percent more consumption next year in order to forgo consumption today, and 259 percent more consumption ten years from now in order to forgo consumption today. In this model, the same parameter value d describes preferences over any time horizon for a given individual.

As the neoclassical model of PDRs shows, PDRs are not fixed quantities.[20] Rather, they decline as consumption today increases relative to consumption in the future. This implies that when individuals are free to borrow and save (i.e., frictionlessly) at the market interest rate r, individuals will adjust consumption in each period until $d = r$. This remarkable prediction says that when individuals are free to adjust borrowing and saving, the rate at which they are willing to exchange current for future consumption will equal the rate at which the market, through the interest rate, will allow them to trade current for future consumption.

In this model of frictionless borrowing and saving, any interpersonal variation or heterogeneity in PDRs must be due to interpersonal variation in borrowing or lending rates. In the real world, of course, there is substantial variation in individual borrowing and lending rates based on differences in individual histories of loan repayment, credit ratings, and other factors. Young individuals without a track record of paying off debt on time are likely to face higher market interest rates than older individuals who have a good record of loan repayment. Better educated and better paid individuals are able to borrow at lower rates because lenders perceive that they are less risky, i.e., will be better able and more likely to repay loans in the future.

Frictions in credit markets introduce another source of PDR heterogeneity. Such frictions arise when individuals are credit (liquidity) constrained and thus unable to borrow at all or unable to borrow as much as they would like at the interest rate they confront. Liquidity constraints raise affected individuals' PDRs relative to market interest rates.

Another strand of literature, discussed beginning on page A-26 under the rubric "behavioral economics," has challenged the standard economic model of PDRs described here. This literature challenges many of the assumptions of the standard model, such as that PDRs are invariant to the time horizon over which a decision is being made or the

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[20] For a presentation of the standard neoclassical model, see, Shane Frederick, George Loewenstein, and Ted O'Donoghue, "Time Discounting and Time Preference: A Critical Review," *Journal of Economic Literature* 40, No. 2 (June 2002): 351–401. doi: 10.1257/002205102320161311.

amounts involved in the decision. Some of this literature goes so far as to challenge the very rationality of much intertemporal decision-making. This literature essentially offers additional reasons for the heterogeneity in PDRs. We discuss the behavioral economics literature at the end of this review because many of its findings are useful for the design of a financial literacy program for military personnel.

C. Measurement of Personal Discount Rates

PDRs cannot be directly observed, but must be inferred from intertemporal choices. This section discusses what the revealed choices that individuals make regarding current and future sums imply about their PDRs. It then discusses a methodology for estimating the distribution of PDRs from the observed choices.

1. Choices Involving Current and Future Sums

Consider an individual who is offered some future payment *F* and must wait *t* years before receiving it. What current value *V* does the individual place on the future payment *F*? If the individual has PDR *d*, the individual will place the value $V = F/(1+d)^t$ on the future payment *F*; *V* is just the present value of the future payment discounted at the rate *d*. If $V = F/(1+d)^t$, the individual is said to be indifferent between *V* and *F*. The quantity *d* summarizes the degree of indifference. If, instead of being offered a single future payment *F*, the individual is offered a stream of future payments $F_1, F_2, \ldots, F_T$, then *V* is the present value of the future payment stream discounted at the rate *d*.

Now suppose that the individual is choosing between a current amount *C* and a single future amount or stream of future payments. The breakeven discount rate *b* is defined to be the discount rate that equates the current amount *C* with the present value of the future amount or stream of future payments. To be explicit, in the case of a future payment stream, the breakeven rate is the discount rate *b* such that $C = \sum_{t=1}^{T} \frac{F_t}{(1+b)^t}$. We can thus infer that if the individual's PDR *d* equals the breakeven rate *b*, the individual will be indifferent between the current amount *C* and the future amount or stream of future payments (i.e., $V = C$). It thus follows that if the individual discounts the future payments at a higher rate than *b* ($d > b$), $V < C$ and the individual will prefer the immediate amount *C* to the stream of future payments. In the last case, we can infer that if $d < b$, the individual will place a higher value *V* on the future stream than the current amount *C* and thus prefer the future payment stream. As the next section shows, these inequalities can be used to infer PDRs from observed choices that individuals make between current and future values.

2. A Methodology for Estimating Personal Discount Rates

Economists have used various empirical methodologies for estimating the distribution of PDRs with data on observed choices. This section describes the methodology used by

Warner and Pleeter (hereafter WP) and Simon, Warner, and Pleeter (hereafter SWP),[21] whose methods are representative of the literature. Their method starts with the fact that one cannot directly observe individuals' PDRs, only the choices they make. What we know is that if an individual chooses a current amount *C* instead of a future amount or stream of future payments, the individual has a PDR that exceeds the breakeven rate on the choice ($d > b$). Alternatively, if the individual chooses the future amount or payment stream, we know $d < b$. Let $P(C)$ denote the probability of choosing the current amount *C* over the future amount or stream of payments. Since $P(C) = P(b > d)$, it is clear that when b increases (indicating that the current amount *C* has decreased relative to the future payments), $P(C)$ will go down.

To implement this probability expression empirically, one must make an assumption about the distribution of *d* in the population being studied. To introduce the methodology, we begin with the assumption that *d* is distributed normally with mean (expected value) μ and standard deviation σ. In this case, *d* is distributed symmetrically around μ, and the standard deviation σ measures the spread in PDRs around the mean. Furthermore, since the distribution is symmetric around μ, μ is also the median PDR.

The assumption that *d* follows a normal distribution implies that $P(C) = P(d > b) = P(\frac{d-\mu}{\sigma} > \frac{b-\mu}{\sigma})$. Since $\frac{d-\mu}{\sigma}$ is a standard normal variate, which we will symbolize by *z*, it follows that $P(C) = P(z > \frac{b-\mu}{\sigma}) = P(\frac{\mu-b}{\sigma} > -z)$. Since –z also follows a standard normal distribution, we can finally write that $P(C) = \Phi\left(\frac{\mu-b}{\sigma}\right)$, where $\Phi\left(\frac{\mu-b}{\sigma}\right)$ represents the cumulative standard normal distribution evaluated at $\frac{\mu-b}{\sigma}$. This suggests a probit model of the probability of choosing the current amount C:

$$P(C) = \Phi(\beta_0 - \beta_1 b), \quad \text{(A-1)}$$

where $\beta_0 = \mu/\sigma$ and $\beta_1 = 1/\sigma$. With variation in breakeven discount rates across the members of a population, the mean and standard deviation of the distribution of PDRs may be computed from probit estimates of the parameters β_0 and β_1.

The assumption that *d* is distributed normally has one unfortunate implication—it permits the possibility of negative PDRs. Negative PDRs are implausible because they imply that individuals are indifferent between a given amount today and smaller amounts in the future, implying economic irrationality when market interest rates are non-negative. A distribution that avoids this possibility, and restricts PDRs to be strictly positive, is the

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[21] John T. Warner and Saul Pleeter, "The Personal Discount Rate: Evidence from Military Downsizing Programs," *American Economic Review* 91, No. 1 (March 2001): 33–53, http://www.jstor.org /stable/2677897; Curtis J. Simon, John T. Warner, and Saul Pleeter, "Discounting, Cognition, and Financial Awareness: New Evidence from a Change in the Military Retirement System," *Economic Inquiry* 53, No. 1 (January 2015): 318–34, doi: 10.1111/ecin.12146.

log-normal distribution. If d is distributed log-normally, then log(d) is distributed normally with mean μ and standard deviation σ. In this case, the proper form of the probit model for $P(C)$ is

$$P(C) = \Phi(\beta_0 - \beta_1 \log(b)). \quad \text{(A-2)}$$

If d is distributed log-normally, the expected PDR is $E(d) = \exp(\mu + 0.5\sigma^2)$, where *exp* denotes exponentiation. This expression for the expected PDR reveals that it depends on both the mean and standard deviation of log(d). If d is log-normal, its distribution is not symmetric. Rather, it is left-skewed with a median equal to $M(d) = \exp(\mu)$. In this case, the median PDR will be less than the expected PDR. While many distributions of d are possible, both WP and SWP indicate that the log-normal distribution fits the observed choices of military personnel well.

Choices over current versus future payments are likely to depend on factors other than the breakeven discount rate. PDRs are influenced by demographic factors such as age, education, gender, and race, as well as other factors that are likely to bear on the choice. In the context of equation (A-2), it is easy to add these factors, represented in equation (A-3) by the matrix X, and estimate their impacts (represented by the symbol δ) on the probability of taking the current amount C:

$$P(C) = \Phi(\beta_0 - \beta_1 \log(b) + X\delta). \quad \text{(A-3)}$$

From the probit model estimates of equation (A-3), one can compute the effect of each factor in X on the expected PDR.[22]

D. Studies Based on Data Involving Military Personnel

This section first identifies the types of empirical studies upon which PDR estimates are based. It then reviews in some detail estimates from three studies of PDRs of military personnel. Two of these studies were based on natural experiments—the Drawdown program of the early 1990s and the repeal of the REDUX military retirement system in FY 2001. The third study was based on information contained in the August 2004 SOF survey. Finally, it reviews evidence from non-military studies of PDRs and compares estimates from this literature with estimates from the military studies.

1. Types of Studies

Empirical studies of PDRs are based on experimental data and field data. Experiments are typically conducted in controlled settings in which subjects are offered various choices between different current and future payments and their choices are observed. PDRs are

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[22] If δ_i is the coefficient on the variable X_i, the change in the expected PDR due to this factor is δ_i/β_1.

estimated from the fact that the breakeven rates, which are controlled by the experimenters, vary across the individuals participating in the study. Randomization of the choice payments in controlled experiments helps ensure that PDR estimates are not contaminated by unobservable factors that might be correlated with, but are not determinants of, PDRs.

Experiments may involve choices in which subjects receive actual cash payoffs, or hypothetical choices that do not involve real payoffs. It is believed that studies involving actual payoffs are likely to provide more credible evidence about PDRs than studies based on hypothetical choices. On the other hand, experiments with actual payoffs are typically constrained by cost to work with relatively small dollar amounts. As discussed in more detail below, PDRs estimated in an experimental framework with low payoffs may not apply to settings involving choices between relatively large current and future amounts. In some experiments, the data are collected in a laboratory setting; in others, through a survey.

Field studies involve ex post analysis of choices that individuals made in some real world setting. Field studies may involve choice amounts that are far larger than the amounts offered in experiments. Sometimes field studies can be credibly classified as "natural experiments." Natural experiments involve situations in which a group of individuals is confronted with a choice that was previously unavailable and could not have been anticipated ahead of time. The inability to anticipate the new choice ahead of time is important, because it means that the pool of people eligible for the new choice is not a result of prior individual self-selection. That is to say, the cohort of individuals eligible for some new choice is random and has not been contaminated by movement into or out of the cohort prior to the choice. Field studies that cannot be credibly classified as natural experiments must rely on econometric techniques to control for sample selection bias and other confounding factors that might bias estimates of PDRs.

2. Three Studies Based on Data Involving Military Personnel

The first two studies qualify as quasi-natural experiements. While not controlled experiments, they both involved situations in which personnel were confronted with choices that were neither previously available nor could have been anticipated prior to the implementation of the programs. The third represents a survey experiment in which personnel were confronted with hypothetical choices regarding military retirement payments.

a. The Downsizing Program of the Early 1990s

After the fall of the Berlin Wall in 1989, the Department of Defense (DoD) was confronted with the problem of how to downsize the Active Duty force from about 1.9 million personnel to 1.5 million. DoD officials knew that, in order to avoid future imbalances in the years-of-service (YOS) distribution of the force, it would have to effect the reductions across the YOS spectrum, not just by reducing new accessions. But to reduce the mid-career (YOS 7–15) force without some form of separation payment would be seen by many as unfair and would hurt morale. After much negotiation between DoD and the Congress about how to construct a downsizing program, a program was implemented at the start of FY 1992 that offered eligible personnel in the YOS 7–15 interval a choice between a lump sum separation benefit and an annuity. The annuity was called the Voluntary Separation Incentive (VSI) and the lump sum payment was called the Selective Separation Benefit (SSB). Monthly VSI payments were set equal to 2.5 percent of final monthly basic pay (BP) times YOS. Payments were to be received for a number of years equal to twice the member's YOS. The benefits were not indexed for inflation. The SSB alternative provided a lump sum payment of 15 percent of annual BP multiplied by the member's YOS (i.e., the equivalent of six years of VSI payments as a lump sum). (The SSB was thus equal to 1.5 times the payment received in the event of involuntary separation.) Importantly, DoD went to great lengths to inform personnel about the programs. The DoD Compensation Directorate prepared a pamphlet explaining the program and distributed it to all affected personnel. Furthermore, articles in the Service newspapers and in the general media explained the characteristics of each program. Individual counseling was also made available to individuals requesting further clarification.

WP conducted a detailed study of the choices that personnel affected by the downsizing program made during the first two years of the program (FY 1992–1993). DMDC provided the data for the study at the individual level. The database included the individual's separation benefit choice, detailed individual demographic characteristics and Military Service factors (Service, rank, occupation, etc.). The database contained information on approximately 59,000 officers and 235,000 enlisted personnel who were eligible for separation payments in the two-year period. Of those eligible for separation payments, approximately 11,000 officers and 55,000 enlisted personnel actually separated under the program and thus made separation payment choices.

Table A-2 comes directly from WP. As the table shows, eligible Service members were selecting between sizeable SSB payments and sizeable VSI payments. Based on low discount rates (e.g., 7 percent or 10 percent), the present value of the annuity payments exceeded the present value of the lump sum payment by a wide margin. In fact, the before-tax breakeven discount rates for the choices ranged from 17.5 to 19.8 percent. The after-tax breakeven rates were even larger, ranging from 19 to 24 percent.

Table A-2. Characteristics of Choices in the Drawdown

Years of Service	SSB	VSI	Present Value of VSI: 7% DR	10% DR	20% DR	30% DR	Breakeven DR	% SSB	% Sep
Officers									
O-3, 7 YOS	$34,709	$5,785	$54,129	$46,875	$32,002	$24,430	0.175	70.7	35.5
O-3, 9 YOS	$46,219	$7,703	$82,908	$69,497	$44,485	$33,085	0.189	52.1	47.8
O-4, 12 YOS	$72,006	$12,001	$147,276	$118,005	$71,106	$51,904	0.196	36.2	8.0
O-4, 15 YOS	$94,114	$15,686	$208,274	$162,645	$93,722	$67,950	0.198	29.8	6.8
Enlisted									
E-5, 7 YOS	$16,655	$2,776	$25,973	$22,492	$15,356	$11,722	0.175	95.1	6.3
E-5 , 9 YOS	$22,283	$3,714	$39,972	$33,506	$21,447	$15,951	0.189	94.8	28.1
E-6, 12 YOS	$35,549	$5,925	$72,710	$58,259	$35,105	$25,625	0.196	88.1	13.2
E-7, 15 YOS	$51,216	$8,536	$113,342	$88,510	$51,003	$36,978	0.198	74.3	8.0

DR – discount rate; % Sep – percent separating among individuals with the given rank and YOS eligible for the downsizing program.

Despite these extremely high breakeven rates, large percentages of separating personnel opted for the lump sum. In fact, much higher percentages opted for the lump sum than analysts in DoD had thought would do so beforehand. For example, among the officers with less than 10 YOS, more than half took the lump sum. Among the E-5 enlisted personnel with less than 10 YOS, over 90 percent did so. Almost 75 percent of E-7 enlisted personnel with 15 YOS took the lump sum. Even among the more senior officers, 30 percent or more took the lump sum. Overall, about half of the officers chose the lump sum, while over 90 percent of the enlisted personnel did so. The high percentages of personnel opting for the lump sums despite the high breakeven rates implies very high PDRs.

After calculating the breakeven rate for each participant in the Drawdown program, WP estimated a probit equation for officer benefit choices and a probit equation for enlisted benefit choices based on equation (A-1) on page A-6.[23] In addition to the breakeven rate (entered linearly and then log-linearly), their equations included controls for age, education group, race, marital status, number of dependents, Census region, Service, 1-digit DoD military occupation group and fiscal year of the choice. Their enlisted model also included controls for Armed Forces Qualification Test (AFQT) category I (AFQT > 92), AFQT category II (AFQT between 65 and 92), and AFQT category IIIA (AFQT between 50 and 64). Finally, both models included the size of the lump sum payment to test a hypothesis discussed in the PDR literature that individuals apply a higher discount rate to choices involving small sums than large sums.

A summary of WP's main findings are summarized in Table A-3. The table shows the mean PDR estimates for officer and enlisted personnel and the change in the mean PDR due to various factors. It must be stressed that because the VSI amounts were not inflation-protected, these are *nominal* discount rates, not real ones. As WP discuss, the annual inflation rate at the time of the downsizing program was about 3 percent and had been for some time. Assuming individual expectations about future inflation in this range, the real PDRs implied by the downsizing program would have been about 3 percentage points lower than the nominal ones shown in Table A-3.

Consistent with the relatively high breakeven rates and the high percentages of personnel taking the SSB, the linear model produced mean PDR estimates of 10.4 percent for officers and 35.4 percent for enlisted personnel.[24] Estimates based on the log-linear

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[23] More technically, they estimated a bivariate probit model for (1) the choice to separate and (2) the benefit choice conditional on separation. The purpose of the bivariate probit model was to control for any selection bias that might arise if separation benefit choices are correlated with the decision to separate. The analysis indicated that some self-selection was involved but that self-selection did not have a large impact on the estimates obtained.

[24] Since about half of the officers selected the lump sum, an observant reader will ask why, for the linear model, the expected officer PDR was not closer to their average breakeven rate. The answer has to do with correction for sample selection related to the decision to separate. The linear model estimate of the

model were even larger. The relatively high estimates of the mean PDR for enlisted personnel is consistent with the fact that over 90 percent of enlisted personnel took the SSB despite breakeven rates ranging from 19 to 24 percent.

According to the estimates in Table A-3, PDRs tend to decline with age and education level, but are higher for males than females, blacks than whites, and personnel with more dependents. The differences by education level and by race are, in fact, quite striking. Among enlisted personnel, PDRs tend to decline as AFQT increases. Interestingly, the propensity to take the SSB declined with the amount of the SSB, providing support for the hypothesis that PDRs decline when the choice involves larger sums of money.

Table A-3. Nominal PDR Estimates Based on Drawdown Program

	Officers	Enlisted
Expected PDR (Linear Model)	0.104	0.354
Expected PDR (Log-Linear Model)	0.187	0.536
Standard Deviation of PDR (linear Model)	0.170	0.128
Change in PDR due to:		
Age	-0.003	-0.003
Male	0.008	0.034
Black	0.063	0.035
White	-0.017	-0.008
Number of Dependents	0.018	0.007
Graduate Education	-0.075	
College Education	-0.029	
Some College		-0.048
High School Graduate		-0.015
AFQT Category I (AFQT >93)		-0.016
AFQT Category II (AFQT 65-93)		-0.006
AFQT Category IIIA (AFQT 50-64)		0.002
Lump sum Amount ($10K)	-0.055	-0.059

Note: The mean estimates of the PDR are from Table 6 of WP. The standard deviation of the PDR as well as the changes in the mean PDR due to various factors are from Tables 4 and 5, respectively, of the same source. All effects other than the AFQT Category IIIA effect for enlisted personnel are statistically significant at the 0.1 level or better.

Table A-3 indicates that PDRs are related to the size of the payment amounts over which individuals are choosing. WP calculated that about half of the difference in the estimated PDRs of officers and enlisted personnel was due to differences in the size of the

expected officer PDR that does not correct for sample selection was about 18 percent. Sample selection related to the decision to separate was more apparent in the officer data than in the enlisted data.

choice amounts. In other words, had the enlisted personnel been choosing over amounts as large as the officers were, they would have exhibited lower PDRs. Because the size of the payment amounts in the cash-out options that will be available under the new retirement system are likely to be much larger than those available during the Drawdown program, this result implies that new retirees will be likely to apply lower discount rates to the second-career annuity streams to be received under the BRS than personnel applied to the SSB/VSI choice during the downsizing era.

b. Repeal of REDUX and the CSB Program

Prior to 1986, military retirees with 20 or more YOS received a monthly retirement annuity equal to 0.025 times YOS times the average monthly BP for the highest 36 months of service. This system, known as “High-3,” was fully adjusted annually for changes in the Consumer Price Index (CPI). A retiree with 20 YOS would therefore typically receive an annuity equal to 50 percent of BP.

In an effort to reduce retirement costs, the Military Reform Act of 1986 replaced the High-3 system with a less generous military pension system known as REDUX. Applying to personnel who entered service on or after August 1, 1986, REDUX featured:

- An annuity between separation and age 61 equal to 40 percent of BP for 20 YOS;
- A 3.5 percent increase for every YOS beyond YOS 20;
- Restoration at 62 of the pension the individual would have received under High-3; and
- An annual inflation adjustment equal to CPI growth minus 1 percentage point.

REDUX thus reduced the second-career annuity from 50 percent to 40 percent of BP for 20-year retirees and from 62.5 percent to 57.5 percent for 25-year retirees. A 30-year retiree would receive the same initial second-career annuity—75 percent of BP—under either system. However, because of its incomplete inflation adjustment, the real value of REDUX annuities would decline by 1 percent per year between separation and age 61 and by 1 percent per year after the age 62 reset.

The National Defense Authorization Act of 2000 repealed REDUX and restored the High-3 system to all Military Service entrants on or after October 1, 2000. To address those already in service, the Act gave personnel covered by REDUX the option of either (1) returning to the High-3 system or (2) remaining under REDUX and receiving a $30,000 bonus, called the Career Status Bonus (CSB). Personnel must make this choice during their fifteenth YOS (and not prior to YOS 15). Because the relative values of the two retirement systems vary across individuals with different ages, ranks, and expected retirement dates, the breakeven discount rate varies by individual as well.

SWP conducted a detailed analysis of the choices that eligible personnel made under this program.[25] DMDC constructed the data required for this study, providing the researchers with both an administrative dataset and a survey dataset (DMDC 2008, 2009). DMDC constructed the administrative dataset by identifying all Active Duty personnel who reached YOS 15 sometime between the start of FY 2001 and the end of FY 2007. In addition to the usual demographic and Service history information (i.e., age, education, race, gender, marital status, number of dependents, Military Service, rank, military occupation, and, for enlisted personnel, AFQT), DMDC provided the researchers with Defense Financial Accounting Service data on total military pay, CSB receipt, and member participation in the Federal Thrift Savings Plan (FTSP). The administrative dataset contained information on approximately 190,000 individuals.[26]

DMDC's survey, developed jointly by the researchers and DMDC staff, supplemented the information in the administrative dataset. A stratified random sample of 46,566 Active Duty members were given the survey in October 2008. DMDC received 19,272 completed surveys (with "completed" defined to be a survey received with answers to more than 50 percent of its questions). After eliminating individuals who reported that they were not in fact eligible to receive a CSB (all were officers) and individuals with other missing information, the dataset contained 13,461 usable survey observations: 12,025 enlistees and 1,436 officers. The survey provided much evidence about the financial condition of the personnel making the CSB/REDUX versus High-3 decision, their savings habits, and their awareness of the different features of the REDUX and High-3 retirement systems. CSB takers were asked about how they used the bonus. Both takers and non-takers were asked whether, in retrospect, they made the correct decision. Findings with respect to these questions are summarized on pages A-19 and A-20.

The survey data were found to be representative of the larger administrative data in terms of the CSB/REDUX take rate, FTSP participation rate, and other factors. Because of this, and because of the extra information provided by the survey, the analysis focused on the survey data. Overall, 48.5 percent of enlisted personnel in the survey data chose CSB/REDUX, while only 13.4 percent of officers did so. Breakeven discount rates were

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[25] Aline Quester and Lewis Lee, with Ian McLeod, *The Retirement Choice*, CRM D0003713.A4/2REV, originally published as CNA Research Memorandum 3713.A1 in April 2001 (Alexandria, VA: CNA Corporation, 2004), http://www.public.navy.mil/bupers-npc/organization/npc/IM/corporatessystems /Documents/TheRetirementChoice.pdf; Aline Quester and Robert Shuford, *Get Paid Now or Get Paid Later: What are Sailors Deciding?*, CRM D0013312.A1/Final (Alexandria, VA: CNA Corporation, 2005), https://www.cna.org/CNA_files/PDF/D0013312.A1.pdf; and Keith Brown and Michael Moskowitz, *Friendly Advice and Time Discounting: The Case of Retirement Choice in the Military* (Arlington, VA: CNA Corporation, 2007, unpublished) provided analyses of choices made by Navy enlisted personnel under the CSB/REDUX program.

[26] The dataset was actually longitudinal, providing data on each individual for every year between FY 2001 and FY 2007.

calculated for survey participants.[27] A difference from the downsizing study is that SWP accounted for the state income tax liability as well as the federal tax liability associated with each choice. The average breakeven discount rate for enlisted personnel was computed to be 7.5 percent while the average breakeven rate for officers was computed to be 10.2 percent. The top panel of Figure A-1 shows histograms of the breakeven rates for enlisted personnel and officers in the study.

Following the methodology described above for estimating expected and median PDRs, SWP estimated probit models of the CSB/REDUX versus High-3 choice, and then used their estimates to calculate expected and median PDRs for each individual based on the individual's demographic characteristics. Histograms of expected *real* enlisted PDRs and expected *real* officer PDRs are shown in the bottom panel of Figure A-1.[28] It is apparent from these histograms that officers have lower expected PDRs and the dispersion in expected rates is lower for them.

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[27] The breakeven rate for the CSB/REDUX choice depends crucially on career length and declines as completed career length increases because (1) the difference between the REDUX annuity increases relative to the High-3 annuity as YOS increases beyond 20 and (2) the older the age at separation, the fewer the years of retired pay loss between age at separation and age 62. Importantly, the survey asked participants about their expected career length, which was unobservable in the administrative data.

[28] The word "real" is intentionally emphasized. Breakeven rates and discount rates estimated with data from the CSB/REDUX program are in fact real rates, because the real value of future annuity payments under either High-3 or REDUX are invariant to the actual inflation rate. Furthermore, since the inflation adjustment mechanism is known in advance, there is no uncertainty about the real value of future payments, except for the (unlikely) possibility that the mechanism might be changed by a future Congress.

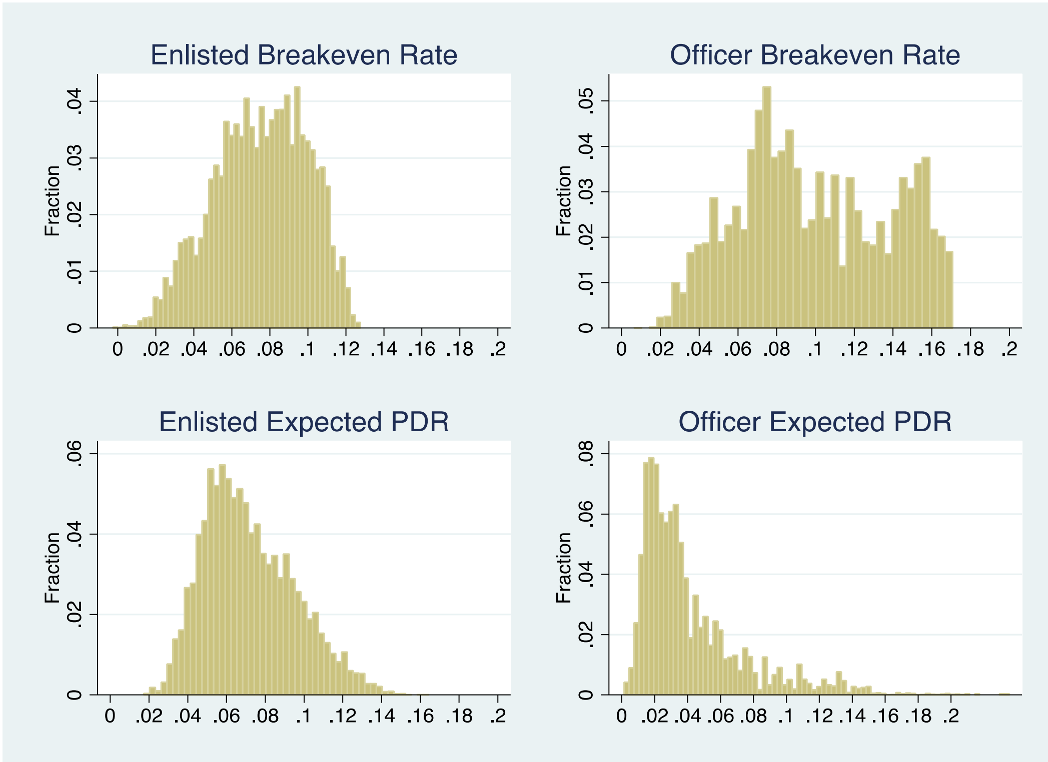

Figure A-1. Histograms, Breakeven Discount Rate (top), and Expected PDR (bottom)

Using their estimated models, SWP calculated expected and median discount rates for various groups shown in Table A-4. The average expected PDR for all officers was found to be 4.3 percent. The median discount rate was found to be much lower, only 1.9 percent. The expected PDR for all enlisted personnel was estimated to be 7.2 percent and the median was estimated to be 6.7 percent.

Table A-4. SWP Estimates of Expected and Median PDRs by Demographic Group

Group	Officer		Enlisted	
	Expected	Median	Expected	Median
All	4.3	1.9	7.2	6.7
AFQT<50			8.0	8.1
AFQT>50			6.8	6.1
White	3.9	1.6	6.5	5.5
Black	8.6	4.5	9.2	10.0
Hispanic	3.2	1.3	6.8	6.2
Male	4.2	1.9	7.3	6.8
Female	4.8	2.3	6.4	5.5
Married	4.3	1.9	7.3	7.0
Divorced	7.3	3.8	7.4	7.0
No Dependents	3.1	1.3	5.1	2.9
One Dependent	3.3	1.4	5.9	4.2
Three Dependents	4.8	2.2	7.1	6.7
High School Dropout			8.6	8.8
Some College, No Degree	9.5	5.2		
Associate			6.4	5.4
College Degree	5.0	2.3	5.9	4.4
Advanced Degree	3.4	1.4	6.3	5.1
Non-Combat Zone	4.4	2.0	6.9	6.3
Combat Zone	4.2	1.8	7.8	7.7

Source: Reproduced from Table 5 of SWP.

Clearly, even after accounting for the fact that the PDR estimates from the Drawdown program were nominal and not real, the personnel making CSB/REDUX choices exhibited lower PDRs than the personnel making separation payment choices during the Drawdown. However, the general pattern of PDRs with respect to demographic characteristics is quite similar. Consistent with the Drawdown study, enlisted personnel with higher AFQT scores were less likely to take CSB/REDUX and therefore exhibited lower PDRs. Also consistent with the earlier study, blacks were much more likely to take CSB/REDUX, and their PDRs were estimated to be much higher than the rates for personnel in other race groups. Furthermore, in both studies, PDRs increased with the number of dependents. Finally, both studies found that those with more education discount future payments at a lower rate.

How can the quite different estimates of PDRs from the WP and SWP studies be reconciled? As discussed above, about 3 percentage points of the differences between the studies is due to the fact that the first study estimated nominal PDRs while the second estimated real ones. More fundamentally, the differences are likely to be due to differences in the context of the choices. The apparently high discount rates that separating personnel exhibited during the downsizing period might have been a result of special circumstances that induced them to opt for the SSB. One abnormal circumstance was the fact that the program was announced relatively suddenly in the fall of 1991, and personnel may not have been able to plan in advance for their departures from service. The suddenness of the program was compounded by the fact that the Drawdown occurred in the middle of a severe recession, with unemployment in excess of 8 percent. As a result of these circumstances, personnel departing from military service under the Drawdown program may have simply lacked the financial cushion to weather the transition from service or a long spell of unemployment. The lack of adequate liquidity to weather the transition may have been aggravated by the fact that military mid-careerists may not have as many non-military pension assets as civilian families with similar ages and incomes. With fewer financial assets to weather a spell of unemployment than civilians might have, separating personnel may have been even more likely to opt for the lump sum separation payments. In contrast, the CSB/REDUX versus High-3 choice did not involve a simultaneous career change and was likely based more on lifetime income or utility maximization.

The SWP study provided other evidence indicating that PDRs of military personnel are likely to be lower than those estimated in the Drawdown study. This evidence comes from the participation of individuals in the CSB/REDUX study in the FTSP. Personnel were first made eligible for participation in FTSP in 2002, but without matching government contributions. Even with no matching funds from the government, 33 percent of enlisted personnel in the CSB/REDUX analysis database contributed to the FTSP and their average contribution is over 6 percent of base pay. Over half of officers contributed an average of 9 percent of base pay. Since, over the past 10 years, the average real rate of return on FTSP investments has been in the 3 percent to 5 percent range, personnel would not be making these investments if their PDRs were above that range.

The DMDC survey provided evidence about the financial situations of the personnel making the CSB/REDUX versus High-3 decision: their savings habits, their participation in the FTSP, and their awareness of the different features of the REDUX and High-3 retirement systems. CSB takers were asked about how they used the bonus. Both takers and non-takers were asked whether, in retrospect, they made the correct decision. The responses to these questions provided insights into the relationship between PDRs and other observed financial behaviors as well as the question of whether individuals appeared to be making rational intertemporal decisions.

- About half of all personnel participated in the FTSP sometime between FY 2002 and FY 2007. Estimated PDRs were strongly negatively related to FTSP participation and to contribution amounts. Individuals who were more patient based on their predicted PDRs demonstrated more patience measured by saving behavior. And, of course, correlation does not imply causality: individuals with excess cash (as demonstrated by being able to defer consumption through saving in the FTSP) had the luxury of being more patient.

- Among survey participants, 53 percent of enlistees and 81 percent of officers reported saving regularly each month. Less than 13 percent of enlistees and only 1 percent of officers reported spending more than their income. Just 10.8 percent of enlistees and 4.3 percent of officers reported spending all of their income. Analysis showed that individuals with lower predicted PDRs were more likely to report on the survey that they "saved regularly."
- About 20 percent of enlistees and 38 percent of officers reported being "very (financially) comfortable;" another 51 percent of enlistees and 48 percent of officers reported being "able to make ends meet without much difficulty." About 22 percent of enlistees and 11 percent of officers reported having "occasional difficulties," and only 8 percent of enlistees and 2 percent of officers reported "being over their head or having trouble making ends meet." Individuals with higher estimated PDRs tended to report higher levels of financial difficulty, although the estimate for officers was statistically imprecise.
- Survey respondents were asked questions to reveal how well informed they were about the four main features of REDUX versus Hi-3 retirement systems. The first main feature of REDUX was the reduction of the annuity at 20 YOS from 50 to 40 percent. At least 92 percent of respondents indicated that they knew of the reduction. A majority of personnel were aware of the other differences between REDUX and High-3 (the difference in post-YOS 20 multiplier, the age 62 REDUX reset and the difference in inflation indexing). In fact, REDUX takers generally indicated more awareness of these features than the non-takers.
- What did CSB recipients do with their $30,000 bonus? Survey participants were asked how they used the money, with seven multiple categories of response. By far the most popular use of the bonus was to pay down debt: about 84 percent of both officer and enlisted takers indicated that they used the money for this purpose. Next in popularity was "investment," with about 44 percent of survey respondents indicating they used the CSB for this purpose. About 16 percent of respondents said they used the money to buy a house. Other uses included buying a car (12 percent), paying for college (5 percent), starting a business (1 percent) and other uses (20 percent). The high percentage indicating that they used some of their CSB payments to pay down debt is indicative of high PDRs. Other uses, such as buying a car, may be indicative of borrowing constraints in credit markets. Using the bonus to make an investment, though, may be unrelated to PDRs.

The survey also asked respondents whether they were satisfied, ex-post, with their choices. Over 90 percent of officers and enlisted personnel who opted for High-3 indicated they made the correct decision compared to only around 60 percent of CSB/REDUX takers. Among the CSB/REDUX takers, individuals who said that they made a mistake were found to be less aware of the differences between CSB/REDUX and High-3, to have more financial difficulties and to be paying higher rates on credit card debt.

c. Evidence from the August 2004 Status of Forces Survey

DMDC's August 2004 SOF survey contains information about hypothetical retirement choices that is directly relevant to the question of what the cash-out rates under the BRS are likely to be under different DoD discount rates. Survey respondents were asked about their willingness to trade the whole second-career retirement annuity (annuity from age at separation to age 62) for a given hypothetical lump sum payment at separation. That is to say, they were asked about their willingness to do a full cash-out. John Warner conducted an analysis of the survey responses and estimated the distribution of implied PDRs for different groups of personnel.[29]

Enlisted respondents with less than 20 YOS were instructed to assume that they will retire as an E-7 at YOS 20 with a retirement annuity of $1,600 per month ($19,200 per year). Officer respondents were instructed to assume that they will retire as an O-5 at YOS 20 with a retirement annuity of $3,200 per month ($38,400 per year). Enlisted respondents were first asked whether they would be willing to forgo the second-career annuity for a lump sum payment at separation of $75,000. If a respondent answered "yes," the questioning stopped. If the respondent said "no," the respondent was then asked whether they would be willing to take a lump sum payment of $100,000 in lieu of the second-career annuity. Again, if the person said "yes," the questioning stopped. But if the person said "no," the question was repeated a third time with a lump sum amount of $125,000. This process repeated up to seven times, ending with a maximum amount (for enlisted personnel) of $300,000. If a person did not accept any of the lump sum amounts, the person was coded as "preferring the current system." The officer questioning was similar but the lump sum payment amounts were larger, beginning with $200,000 and ending with $425,000. All in all, officers and enlisted personnel were confronted with a maximum of seven lump sum alternatives to the current system. The choices and the frequency distribution of officers and enlisted personnel opting for the various choices is displayed in Table A-5.

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[29] John T Warner, *More Evidence on Personal Discount Rates of Military Personnel*, unpublished report prepared for the Defense Advisory Committee on Military Compensation (Clemson, SC: Clemson University, Department of Economics, August 5, 2005).

Table A-5. Choice of Retirement Alternative in 2004 Status of Forces Survey

Lump Sum Payout Option	Choice	Percent	Cumulative Percent	PDR Interval (%)
Enlisted Personnel				
Current System	1	35.2	35.2	0–3.5
Alt System with $300K LS	2	11.0	46.2	3.5–5.8
Alt System with $250K LS	3	5.9	52.1	5.8–8.8
Alt System with $200K LS	4	5.2	57.3	8.8–13.8
Alt System with $150K LS	5	14.0	71.3	13.8–17.5
Alt System with $125K LS	6	9.5	80.8	17.5–23.5
Alt System with $100K LS	7	8.6	89.4	23.5–34.3
Alt System with $75K LS	8	10.6	100.0	>34.3
Officers				
Current System	1	49.5	49.5	0–7.0
Alt System with $425K LS	2	14.1	63.6	7.0–9.0
Alt System with $375K LS	3	4.0	67.6	9.0–11.5
Alt System with $325K LS	4	3.7	71.3	11.5–14.8
Alt System with $275K LS	5	5.7	77.0	14.8–17.0
Alt System with $250K LS	6	6.5	83.5	17.0–19.8
Alt System with $225K LS	7	4.4	87.9	19.8–23.3
Alt System with $200K LS	8	12.1	100.0	>23.3

The analysis was conducted using the public use version of the 2004 SOF survey. As a consequence, certain variables, including the respondent's age, were not included in the database. Furthermore, YOS was only provided in three ranges (0–5, 6–9, and 10–19). For the purpose of analysis, Warner assumed that enlisted personnel entered service at age 19 and would receive 22 annual second-career retirement annuity payments between the age of separation and age 62, and that officers entered service at age 23 and would receive 19 annual second-career annuity payments between age at separation and age 62. Under these assumptions, one can compute the breakeven discount rate for each choice. For example, the discount rate that equates the present value of the enlisted annuity with the lump sum amount of $75,000 is 34.3 percent. By assumption, respondents who would take a lump sum amount of $75,000 in lieu of the second-career annuity have a PDR of at least 34.3 percent. At the other extreme, the discount rate that equates the present value of the annuity with the highest enlisted lump sum offer ($300,000) is 3.5 percent, implying that personnel who would not accept even this amount must have a PDR of less than 3.5 percent.

Table A-5 indicates that 35.2 percent of enlisted respondents would choose to remain with the current system rather than take the largest lump sum amount offered; 49.5 percent of officers would do so. We can infer from the table that 35.2 percent of enlisted personnel with less than 20 YOS have PDRs below 3.5 percent and half of the comparable officer force has PDRs under 7 percent.

The distribution of PDRs was estimated for different groups of personnel. The estimation involved imputation of PDRs to the individuals in each interval of breakeven rates shown in Table A-5 (see Warner (2005) for details). For different groups, Table A-6 displays the expected PDR and the PDRs corresponding to the 25th, 50th (i.e., the median), and 75th percentiles of imputed PDRs. The expected (mean) PDR of all enlisted personnel was 12.8 percent while the expected PDR of all officers was 10.1 percent.[30] Median PDRs were 7.9 percent (enlisted) and 7.1 percent (officers). These rates are higher than those reported by SWP, but it must be remembered that these rates are based on the whole force and give the largest weights to personnel in the YOS 0–5 range. As Panel B of the table indicates, discount rates decline as YOS (and hence age) group increases. Enlisted personnel in the YOS 10–19 range have an expected PDR of 9.6 percent and officers have an expected rate of 8.6 percent. The median PDRs of these groups are 4.2 percent and 6.4 percent, respectively. Of course, the lower median rate for enlisted personnel in this YOS range is at odds with findings from the two previous studies. A possible reason for this reversal is discussed below.

[30] Matthew Black, "Personal Discount Rates: Estimates for the Military Population," *Final Report of the Fifth Quadrennial Review of Military Compensation*, Vol. 1B, Appendix I (Washington, DC: U.S. Department of Defense, January 1984) also estimated discount rates for military personnel from DMDC survey questions about alternative retirement systems. He estimated an average discount rate of 10.3 percent for officers and 12.5 percent for enlisted personnel. Despite the fact that his data came from a much earlier time period, his mean estimates are very close to the mean estimates presented here.

Table A-6. Estimates of the PDR Distribution Based on August 2004 Status of Forces Data

Status	YOS Interval	20-Yr Career?	Expected PDR	25th Pct	Median	75th Pct
			Panel A			
Enlisted			12.8	2.5	7.9	19.6
Officer			10.1	4.3	7.1	16.1
			Panel B			
Enlisted	0–5		14.4	3.0	12.6	22.4
Enlisted	6–9		12.6	2.6	7.5	19.1
Enlisted	10–19		9.0	1.8	4.2	15.2
Officer	0–5		12.2	5.1	8.8	19.6
Officer	6–9		10.4	4.3	7.1	17.2
Officer	10–19		8.6	3.8	6.4	10.5
			Panel C			
Enlisted	0–5	No	15.5	3.2	14.3	24.0
Enlisted	0–5	Yes	11.7	2.5	6.0	17.8
Enlisted	6–9	No	13.6	2.7	11.4	20.5
Enlisted	6–9	Yes	11.7	2.5	5.6	17.9
Enlisted	10–19	No	15.2	3.9	16.8	19.2
Enlisted	10–19	Yes	8.6	1.8	4.0	14.8
Officer	0–5	No	13.0	5.3	11.1	21.3
Officer	0–5	Yes	10.8	4.9	7.9	16.9
Officer	6–9	No	12.1	4.4	8.2	20.0
Officer	6–9	Yes	9.4	4.1	6.7	14.7
Officer	10–19	No	12.5	5.8	8.5	20.0
Officer	10–19	Yes	8.4	3.7	6.3	9.7

The decline in PDRs with YOS partly reflects the effect of aging, but it also may reflect a sorting effect arising from the fact that the current military compensation system is more attractive to personnel with low discount rates. In fact, the survey contained a question that permits us to disentangle the age effect from the sorting effect of the compensation system. The survey asked personnel how many years they expect to serve on Active Duty. Panel C of Table A-6 breaks down discount rates by whether personnel expect to serve a full 20-year career as well as by officer/enlisted status and YOS category. In each category, personnel who expect to serve at least 20 years on Active Duty exhibit lower discount rates than personnel who expect to depart prior to the 20-year mark. The within-category differences are generally around 2–3 percentage points.

The pattern of PDRs obtained with the survey data is consistent with the earlier studies. The main anomaly is that in certain YOS groups, officers are estimated to have higher median PDRs than enlisted personnel. This result may be due to the differences in the monetary amounts on which the alternatives were based and PDRs imputed. Notice that in Table A-5, the alternative 1 breakeven rate for enlisted personnel is 3.5 percent while it is 7 percent for officers. It could be that a high percentage of the 49.5 percent of officers choosing to remain with the current system have quite low discount rates, but the imputation method assigns to officers choosing the current system an average rate of 3.5 percent (the midpoint rate of possible PDRs in the group). Had the dollar amount of the most generous officer alternative been larger, it is likely that the officer estimates would have been lower.

3. Studies Based on Non-Military Data

Frederick, Loewenstein, and O'Donoghue provide a comprehensive survey of the economic literature on intertemporal choices and time-discounting.[31] Table A-1 (on page A-3) reproduces Table 1 of their survey and includes 34 experimental and 8 field studies conducted between 1978 and 2002. The studies varied according to the length of time between the current and deferred choices, whether the choices were real or hypothetical, the amounts of the choices that involved money, and what was offered when the choice did not involve money (e.g., health; life-years; rice; money versus other goods, including rice, corn, and heroin).

Here we highlight the main findings of their survey as well as findings of several more recent studies. Inspection of Table A-1 shows a huge range of PDR estimates from the various studies. Frederick, Loewenstein, and O'Donoghue summarize the state of knowledge about PDRs as follows:

> the large empirical literature devoted to measuring discount rates has failed to establish any stable estimate. There is extraordinary variation across studies, and sometimes even within studies. This failure is partly due to variations in the degree to which the studies take account of factors that confound the computation of discount rates (e.g., uncertainty about the delivery of future outcomes or nonlinearity in the utility function). But the spectacular cross-study differences in discount rates also reflect the diversity of considerations that are relevant in intertemporal choices and that legitimately affect different types of intertemporal choices differently. Thus, there is no reason to expect that discount rates should be consistent across different choices.[32]

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[31] Shane Frederick, George Loewenstein, and Ted O'Donoghue, "Time Discounting and Time Preference: A Critical Review," *Journal of Economic Literature* 40, No. 2 (June 2002): 351–401, doi: 10.1257/002205102320161311.

[32] Ibid., 393.

Not only is the dispersion in mean PDR estimates across studies large, the estimates are generally larger than the estimates for military personnel. As such, the non-military literature is essentially uninformative about the mean PDR, or the distribution of PDRs, of military personnel. Literature published since 2002 does not change this conclusion.

The larger estimates from the non-military studies appear to be related to the following factors:

- **Small choice amounts**. Individuals are likely to discount small future amounts at a higher rate than large future amounts. Individuals who would prefer $100 today to $110 a year from now may prefer $11,000 a year from now to $10,000 today. In fact, the downsizing analysis was consistent with this hypothesis.
- **Short time horizons**. Individuals may apply a larger (annualized) discount rate to future values involving a short delay than to future amounts involving a longer delay, what the literature terms “hyperbolic discounting.” Many of the experiments involved delays ranging from days to weeks or months. The military downsizing program involved discounting over periods ranging from 7 to 30 years and the CSB/REDUX program involved discounting over periods of up to 40 or 50 years.
- **Risk aversion**. PDR estimates may reflect the combined effect of pure time discounting and risk aversion. Risk-neutral individuals are indifferent between a certain amount and two uncertain amounts with the same expected value (e.g., $100 with certainty versus $90 with a 50 percent chance and $110 with a 50 percent chance). Risk-averse individuals would prefer $100 with certainty over two uncertain amounts whose expected value is $100. Furthermore, risk-averse individuals would be more likely to prefer a *certain* $110 payment one year from now to $100 today than *uncertain* future payments with an expected value of $110 to $100 today. Payments by the government to military veterans might be viewed as more certain than payments from other sources.
- **Younger ages of experiment participants**. Many of the experiments involved college students, who are likely to be less patient, and more liquidity constrained, than the older populations of military personnel in the studies discussed above.
- **Personal financial condition**. SWP provides evidence that military personnel are generally in better financial condition than comparably aged and educated civilians, and that discount rates vary with financial condition.[33] Using data about the financial condition of civilians in the National Financial Capability

[33] See SWP, Appendix E, for further discussion.

Study, the Financial Industry Regulatory Authority compared the financial condition of civilians with the financial condition of the military personnel surveyed by DMDC as part of the CSB/REDUX study. Groups of civilians who are comparable in age, gender, and education to officers and enlisted personnel were selected for comparison. The civilian counterparts reported poorer savings habits (more likely to spend more than income and less likely to save on a regular basis) and more difficulty paying bills on time. Furthermore, SWP found that personnel who reported poorer savings habits and more difficulty paying bills had higher PDRs. By implication, based on their generally weaker financial condition, civilians are likely to have higher, not lower, PDRs than military personnel.[34]

E. Literature on Financial Decision Making

The neoclassical model of intertemporal choice is based on the assumption that individuals are fully rational agents who are able to maximize lifetime utility subject to market constraints. Over the past 30 years, researchers in various disciplines, including economics, finance, and psychology, have begun to question the degree of rationality that individuals display in intertemporal decision-making. They have offered alternative paradigms for how people make intertermporal decisions and whether those decisions are affected, and hopefully improved, through financial education programs and government policies toward saving and retirement.

Behavioral Economics. The alternative empirical paradigms fall under the rubric of "behavioral economics." Behavioral economics attempts to model certain apparent inconsistencies, or anomalies, between the predictions or implications of the neoclassical model and observed behavior. Some of these inconsistencies and hypothesized reasons for them are as follows.

- **General Economic Illiteracy**. Albert Einstein once claimed that compound interest, not $E = MC^2$, was the greatest invention of mankind. Despite that claim, many people have little understanding of the power of compounding and its ability to convert small sums today into large sums in the future (or vice versa).

[34] According to a study (Chabris et al., "Individual Laboratory-Measured Discount Rates Predict Field Behavior," *Journal of Risk and Uncertainty* 37, No. 2 (December 2008): 237–69, doi: 10.1007/s11166-008-9053-x), measured PDRs are also related to a variety of risky non-financial behaviors. They conducted an experiment that measured participants' PDRs and then related them to body mass index, amount of exercise, smoking, and diet. While the correlation between measured PDR and each of these behaviors was low, the correlations were higher than correlations between these factors and any other variable (e.g., age, education, etc.). The authors state that "our results support two broad conclusions: (1) there exists a domain-general behavioral disposition towards impatience/impulsivity, and (2) a discount rate estimated through a set of intertemporal monetary choice questions constitutes a useful, though noisy, measure of this disposition." (264)

And many people do not know the difference between the various financial instruments available in the markets (e.g., stocks and bonds). Behavioral economists use these facts as evidence that individuals are ignorant, or at least not fully informed, when it comes to intertermporal decision-making.

- **Non-Constant Discounting**. According to the neoclassical model, the annualized value of the PDR (i.e., its rate per year of calendar time) is independent of time units, i.e., whether time is measured in weeks, months, years, or decades. If an individual places a value of $\$1/(1+d)$ on a dollar to be received one year from today, rational behavior would say that the individual would also place a value of $\$1/(1+d)^2$ on a dollar to be received two years from today, a value of $\$1/(1+d)^3$ on a dollar to be received three years from now, and so forth. Many of the experimental studies of PDRs surveyed by Frederick, Loewenstein, and O'Donoghue have tested the constant discounting assumption by asking individuals about their preferences over different amounts to be received at various times in the future and testing whether the implied annualized discount rates implied by the choices are the same.

  Most of them reject the constant discounting assumption in favor of "hyperbolic discounting." Hyperbolic discounting implies that the individual discounts sums to be received over short periods of time at a higher rate than sums to be received farther out into the future.

- **Magnitude Effects**. The neoclassical model implies that PDRs should be independent of the magnitude of the choice amounts. Magnitude effects suggest that individuals who would prefer \$100 today to \$110 a year from now may prefer \$11,000 a year from now to \$10,000 today. The empirical studies consistently find evidence in favor of magnitude effects and use this evidence to reject the neoclassical model. Neoclassical economists, though, reject the claim that magnitude effects are inconsistent with rational behavior.[35]

- **Sign Effects**. Thaler discusses evidence that individuals apply higher discount rates to events involving pleasure than events involving pain.[36] People pay off

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35 All decisions involve some cost of collecting the information required to make an informed decision. If the cost of collecting information does not increase proportionally with the amounts involved, individuals will rationally collect more information, and make better decisions, when the amounts involved are larger. Furthermore, they are more likely to engage an independent third party to help them with the decision (e.g., a financial advisor). According to this view, magnitude effects just reflect a friction in the market arising from information costs, not an irrationality in decision-making.

36 Richard H. Thaler, "Some Empirical Evidence on Dynamic Inconsistency," in *Quasi Rational Economics*, ed. Richard H. Thaler (New York: Russell Sage Foundation, 1994), 127–33, https://www.russellsage.org/publications/quasi-rational-economics-1.

parking tickets and other penalties (e.g., mortgages and student loans) faster than they are required to by the due dates associated with the penalties.

- **Framing**. In the standard economic model, economic decisions should not depend on exactly how the choices to be made are presented or "framed." But as psychologists Amos Tversky and Daniel Kahneman first showed,[37] how choices are posed does affect the decisions people make. For example, Company A might automatically enroll new employees in its 401(k) savings plan but allow them to opt out by filling out a dis-enrollment form, while Company B only enrolls those who voluntarily enroll by filling out the required paperwork. If new employees are fully rational, both plans should produce the same enrollment rate if other plan features (e.g., minimum employee contribution rate, company contribution match rate and investment vehicles) are the same. But studies conducted prior to the passage of the Pension Protection Act (PPA) of 2006 (see, e.g., Madrian and Shea, and Thaler and Benartzi[38]) showed that employee participation is higher in firms that auto-enroll new employees. The passage of the PPA was due in part to the evidence provided by these studies. Beshears et al. present evidence that 401(k) plan participation increased after passage of the PPA.[39]

- **Annuitization Decisions**. Should individuals use their accumulated savings (assets held in individual accounts or defined contribution plans) to buy lifetime annuities from life insurance companies upon retirement? Annuitization is believed to be rational because it protects individuals from outliving their assets and being destitute in the late stages of life. In fact, an analysis by Yaari claimed that fully rational, risk-averse individuals should almost always annuitize.[40] Despite this prediction, few individuals choose to do so, raising the possibility that the failure to annuitize is due to such factors as ignorance, lethargy, and lack

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[37] Amos Tversky and Daniel Kahneman, "The Framing of Decisions and the Psychology of Choice," *Science, New Series* 211, No. 4481 (January 1981): 453–8, doi: 10.1126/science.7455683.

[38] Brigette C. Madrian and Dennis F. Shea, "The Power of Suggestion: Inertia in 401(K) Participation and Saving Behavior," *Quarterly Journal of Economics* 116, No. 4 (November 2001): 1149–87, http://www.retirementmadesimpler.org/Library/The%20Power%20of%20Suggestion-%20Inertia%20in%20401(k).pdf; Richard H. Thaler and Shlomo Benartzi, "Save More Tomorrow: Using Behavioral Economics to Increase Employee Saving," *Journal of Political Economy* 112, No. 1, Pt. 2 (2004): S164–S187, doi: 10.1086/380085.

[39] John Beshears et al., "Public Policy and Saving for Retirement: The Autosave Features of the Pension Protection Act of 2006," in *Better Living through Economics*, ed. John J. Siegfried (Cambridge, MA: Harvard University Press, 2010), 274–89.

[40] E. M. Yaari, "Uncertain Lifetime, Life Insurance, and the Theory of the Consumer," *Review of Economic Studies* 32, No. 2 (April 1965): 137–50, http://www.jstor.org/stable/2296058.

of financial acumen or, perhaps, lack of trust in insurance companies that sell life annuity policies.[41]

> Despite the claim by Yaari that most people should annuitize accumulated savings upon retirement, whether the failure of most retirees to annuitize is evidence of irrationality in intertermporal decision-making is still a topic of debate among economists.
>
> A recent study by Reichling and Smetters[42] develops a very detailed model of the annuitization decision that accounts for a large number of factors, the key ones being (1) the cost of annuitization (insurance companies charge around 15 percent of the annuitized amount as the fee for service), (2) accumulated wealth at retirement, (3) the degree of risk aversion in consumption, (4) stochastic mortality risk (annual mortality is not certain), (5) the desire to leave assets to heirs, (6) health shocks and the cost of nursing home care if a health shock occurs, and (7) the individual's PDR. They simulate their model over a wide range of parameter values relating to these factors and reach a startling conclusion: *rational individuals or households should never annuitize*.[43] These results suggest that the failure to annuitize is not evidence for ignorance or irrationality of intertemporal decision-making.

Returning to the question of lump sum choices, several recent studies may shed some light on the propensity of future military retirees to cash out part of their second-career annuities. In the civilian sector, individuals save for retirement through defined benefit and defined contribution plans. Prior to retirement, and usually in situations involving job changes, individuals face the choice of whether to (1) take a lump sum distribution from their accumulated (and vested) fund amounts, (2) leave their accumulated amounts in the

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[41] Jeffrey Brown et al., "Why Don't People Insure Late-Life Consumption? A Framing Explanation of the Under-Annuitization Puzzle," *American Economic Review* 98, No. 2 (May 2008): 304–9, doi: 10.1257/aer.98.2.304, find evidence that whether individuals prefer to annuitize depends in part on how the decision is framed. The evidence was provided by an experiment in which participants were offered the choice between a $100,000 investment earning a certain return of 4 percent and several annuity options in lieu of the $100,000. The choice was framed to some participants as an investment decision and to others as a consumption decision. When framed as an investment decision, where the emphasis was placed on the likelihood of not living long enough to get a good return on the amount annuitized, only 21 percent of participants preferred any of the annuity options. But when framed as a consumption decision, where emphasis was placed on the likelihood of running out of savings later in life, over 70 percent of participants said they would choose one of the annuity options.

[42] Felix Reichling and Kent Smetters, "Optimal Annuitization with Stochastic Mortality and Correlated Medical Costs," *American Economic Review* 105, No. 11 (November 2015): 3273–320, https://www.aeaweb.org/articles?id=10.1257/aer.20131584.

[43] The crucial difference between their finding and Yaari's relates to mortality risk. In Yaari's analysis, the annual future mortality risk is known with certainty and based on mortality tables. In Reichling and Smetters' model, annual mortality risk is a random variable whose expected value is given by mortality tables.

current plans, or (3) roll over the accumulated amounts into another employer plan or into an Individual Retirement Account. At retirement, individuals in defined contribution plans face the decision of whether to take a lump sum distribution, self-manage future withdrawals, or buy an annuity. Individuals in defined benefit plans may be able to take a lump sum distribution rather than the future annuity payments for which they are eligible.

Hurd and Panis[44] used panel data from the Health and Retirement Study, which includes individuals aged 50 and above, to analyze these decisions. They found that most pension plans result in a current or future benefit flow or are left to accumulate with the previous employer; only 31 percent of plans (16 percent of dollars) were settled with a lump sum distribution. Less than half of lump sum distributions were cashed out; the rest were rolled over into other retirement accounts or annuitized. When cash-outs occurred, most of the cash went into investments and savings; only 5.6 percent of plans (1.8 percent of dollars) ended up being spent on current consumption or used to pay off debt.

Statistical analysis found that the likelihood of cash-out:

- Is highest for disabled workers and lowest for workers who are at retirement,
- Is bigger for blacks than other race groups,
- Is higher for females than males,
- Decreases as education level increases,
- Decreases as both total wealth and accumulated plan value increase,
- Decreases as the individual's expected chance of living to age 85 increases, and
- Is lower for individuals with health insurance.

None of these results is surprising, and most results for comparable variables are consistent with findings from the military studies, which were conducted on cohorts of much younger workers.

Bütler and Teppa[45] studied the decisions of a sample of Swiss workers who were enrolled in 10 employer-provided defined benefit pension plans to take an annuity or take a full or partial lump sum distribution upon retirement. Overall, 72.5 percent took the annuity while 17.3 percent took a partial lump sum distribution and 10.2 percent took a full distribution. The focus of the study was the relationship between annuity equivalent wealth (AEW) and the percentage of the retirement capital that is annuitized. Retirement capital

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[44] Michael Hurd and Constantin Panis, "The Choice to Cash Out Pension Rights at Job Change or Retirement," *Journal of Public Economics* 90, No. 12 (December 2006): 2213–27, doi: 10.1016/j.jpubeco.2006.06.007.

[45] Monika Bütler and Federica Teppa, "The Choice Between an Annuity and a Lump Sum: Results from Swiss Pension Funds," *Journal of Public Economics* 91, No. 10 (November 2007): 1944–66, doi: 10.1016/j.jpubeco.2007.09.003.

is defined as the actuarial value of future retirement payments based on a risk-free interest rate. AEW is the utility-equivalent of the present value of future annuity payments and accounts for potential risk aversion arising from mortality risk. AEW is calculated under the assumption of risk neutrality and under two assumptions about a risk aversion parameter. Analysis indicated that the fraction of retirement capital that is annuitized rises with AEW, implying that cash-outs are more likely out of accounts that have smaller value (in utility terms). The analysis also found evidence of risk aversion, as models based on positive values of the risk-aversion parameter fit the data better than models based on the assumption of risk neutrality. Males tended to cash out a smaller percentage of retirement capital than females; so did married individuals compared with individuals in other marital statuses. Gender differences were larger among married individuals than non-married individuals.

F. Conclusion

This literature review has yielded the following general conclusions about PDRs:

- PDRs summarize, in percentage terms, individuals' rates of indifference between amounts today and an amount or amounts to be received in the future.
- Empirical studies have indicated that PDRs vary due to observable factors such as age, income, education level, marital status, and race/ethnicity. Of these, the most important factor, quantitatively, is education level. Blacks tend to have higher PDRs than other race/ethnic groups. Gender differences are not statistically significant.
- Even after accounting for observable factors, there is substantial variation in PDRs due to unobservable factors (individual heterogeneity). Such factors include differences in understanding about intertemporal choice, differences in the costs of acquiring information about the choices, liquidity constraints, and differences in upbringing.
- PDRs vary with the time-horizon of the choice, the context of the choice, the credibility of future payoffs, how the choice is framed, and the amounts involved.
- PDR estimates for military personnel are generally lower than PDR estimates for non-military individuals. Two factors that may have played key roles in generating these differences in PDRs are differences in the age of the people involved and the larger amounts over which military personnel were choosing.
- PDRs are correlated with other financial behaviors. In the military context, personnel with lower PDRs are more likely to participate in the FTSP as well as to contribute a larger fraction of their BP.

Within the military studies, context mattered. PDRs revealed by choices made during the early 1990s downsizing program were much larger than PDRs revealed by the choices individuals actually made in the 2001–2007 time period regarding CSB/REDUX or the (hypothetical) choices they said they would make regarding full cash-out of the second-career annuity as part of the August 2004 SOF survey. The higher PDRs that personnel exhibited during the downsizing period may have been due in part to the fact that they were making unexpected job changes at the same time, and liquidity constraints resulting from those job changes may have forced many separating personnel to take the immediate, rather than deferred, separation payments.

Because the CSB/REDUX choice appears more similar to the BRS lump sum decision, we will take the results of SWP as most pertinent to the lump sum choice under the BRS. However, there is still considerable uncertainty about the PDRs that will drive the choices of BRS retirees. For that reason we examine the implications of a range of assumptions about the distribution of PDRs across the individuals making lump sum decisions.

This survey serves as a useful guide to choice of a PDR distribution, or family of distributions, to apply to analysis of the lump sum cash-out option in the BRS. Some of the findings in the studies reviewed should also inform the development of a financial literacy education program for military personnel as well as the financial counseling that personnel receive regarding both individual contribution rates into the FTSP and exercise of the lump sum option at retirement.

Appendix B. Technical Analysis – Lump Sum Take Rate Estimation and Potential Government Savings

A. Methodology

In this appendix, we focus on predicting the take rates and retirement costs of a cohort of new military retirees confronted with different lump sum options. We selected the cohort of FY 2015 retirees from the four Armed Services (Army, Navy, Air Force, and Marine Corps) as a representative cohort for analysis.[46] This cohort of 48,633 retirees includes non-disability Active Duty retirees and Reservists who became eligible for retirement payments (usually at age 60 but in some cases earlier). We excluded disability retirees, who are not eligible for the lump sum option. However, we included non-disability retirees from Active Duty who are eligible for receipt of disability compensation from the Department of Veterans Affairs (VA). This group makes up a significant fraction of non-disability retirees, and their eligibility for VA disability compensation introduces complications that are taken into account in the analysis that follows.

Analysis proceeds through the following steps.

1. Compute DoD Retirement Liabilities without the Lump Sum Option

For each new retiree, we compute the following:

- The expected undiscounted sum of future military retirement payments under the Blended Retirement System (BRS) without the lump sum option,[47]

[46] The data for the analysis were provided by the Office of the Department of Defense (DoD) Actuary. The original source for the data was the Defense Manpower Data Center (DMDC). The DoD Actuary provided data for FY 2011–2015. The data included new Coast Guard retirees and retirees from several other organizations including the Public Health Service; however, these retirees, about 2,000 in number, are excluded from this analysis. Over the period FY 2011–2015, new retirements have averaged 48,910 per year, so the FY 2015 cohort is representative of recent retirements in terms of size. It is also representative along other dimensions (rank distribution, distribution by Service, etc.) Appendix C provides summary statistics on the characteristics of the FY 2015 new retiree cohort.

[47] The BRS reduces military retirement payments by 20 percent across the board. Therefore, each retiree’s retirement payment is multiplied by 0.8 to obtain the payment the individual would receive under the BRS. For the purpose of the analysis, we use the retiree’s net monthly retirement payment (the gross monthly payment for which the individual is entitled minus Survivor Benefit Plan deductions).

- The real expected present value at retirement of these future payments using the real discount rate used by the DoD Actuary (2.5 percent),
- The expected present value of future retirement payments during the individual's second career (defined as the period between retirement age and age 67),
- Life expectancy, and
- The expected number of future retirement payments (life expectancy – retirement age).

Life expectancy was computed from data available from the DoD Actuary on annual death rates of military retirees.[48] The expected present values of future retirement payments were computed by weighting each potential future retirement payment (up to age 110) by the probability that the individual will be alive to receive the payment.[49]

2. Compute DoD Retirement Liabilities with the Lump Sum Option

Assuming a 50 percent lump sum cash-out rate, we compute the following:

- The lump sum amounts for which a new retiree would be eligible based on DoD discount rates used for the computation ranging from 2.5 percent to 20.5 percent (in 1 percentage point increments). Each lump sum amount is the present value of half of the retirement payments the individual would receive from age at retirement until age 67 without cash-out, computed at the given DoD discount rate.
- The DoD retirement liability with cash-out, which equals the lump sum amount at separation, plus the expected present value of all future retirement payments with cash-out, computed at the 2.5 percent discount rate.

3. Account for Differential Taxation of the Retirement Annuity and the Lump Sum Amounts and VA Offsets

a. Differential Taxation of the Retirement Annuity and the Lump Sum Amounts

Because of the graduated tax rates by taxable income in the federal income tax system, differential tax treatment of the military retirement annuity and the lump sum amounts is

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[48] See Department of Defense, *Valuation of the Military Retirement System* (Washington, DC: Office of the Actuary, September 30, 2013), Appendix I, 165–8, http://actuary.defense.gov/Portals/15/Documents/MRF%20ValRpt%202013.pdf. This appendix provides annual death rates of military retirees by age, status (officer or enlisted), and component (Active or Reserve).

[49] See Appendix F, equation (F-7).

likely to have a significant effect on the likelihood that a new retiree will exercise the lump sum option. Specifically, depending on taxable income, the lump sum amounts are likely to be taxed at higher marginal rates than the retirement annuity itself. To account for tax effects, we first have to obtain estimates of new retirees' taxable incomes. For unmarried individuals, taxable income is based on the individual's own income. But 82 percent of new retirees in the FY 2011–2015 period were married, so their taxable incomes will depend not just on their own incomes, but the incomes of their spouses.

To obtain estimates of total income subject to taxation, we used data on military veterans in the American Community Survey (ACS) for years 2010–2014 who appear to be military retirees.[50] The ACS does not specifically identify which veterans are military retirees, so we selected as proxies for military retirees veterans between the ages of 35 and 59 who (1) said that they used TRICARE, and (2) had non-zero retirement income.[51] Using this sample of veterans, we then executed the following steps:

1. Estimate a regression for total income with controls for gender, age, marital status, education level, and race and ethnicity.[52]
2. Use the regression to predict each new retiree's total income (in 2015 dollars).
3. Use 2015 federal income tax tables to compute the new retiree's federal income tax liability.
4. Compute the federal tax liability without military retired pay and the implied marginal tax rate on military retirement payments.
5. Compute the tax liability and the implied marginal tax rate when the individual exercises the option to take a lump sum payment.

The tax liability computations are of course based on the retiree's marital status. We assume that individuals do not itemize (i.e., they take the standard deduction) and that non-married individuals claim one exemption, while married individuals claim three (one for

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[50] The ACS is a large, ongoing survey of households conducted by the US Bureau of the Census. It contains the most complete picture of American households and their socio-economic status of any survey conducted by the federal government. Each year's survey contains approximately 250,000 veterans. ACS data are available at https://usa.ipums.org/usa/.

[51] While the ACS does not break out military retirement income from other retirement income, it is likely that almost all of the retirement income of this group is military retired pay. This is because veterans in the 35–59 age range not on TRICARE have a low average value of retirement income (about $1,300) while veterans on TRICARE and who report retirement income have average reported retirement income of about $25,000, which is not far below the average annual net retirement payment to new retirees in the FY 2011–2015 period ($29,200).

[52] In the case of married individuals, total income equals the income of the individual plus the income of other family members (principally the spouse). For non-married individuals, total income equals personal income.

themselves and two for dependents).[53] Coefficients in the regression for total income are reported in Table D-1 of Appendix D. Appendix D provides details about how the regression for total income was estimated and used to predict the incomes of new retirees.

b. VA Offsets

Disabled veterans, including military retirees, may be eligible for monthly disability compensation payments from the VA. Veterans must apply for a VA disability rating and undergo a medical exam to establish whether their disabilities are service-connected in order to receive VA disability payments. These exams determine the number of medical conditions that are service-connected and the degree of disability associated with each condition. After an exam, the veteran receives a Combined Disability Rating (CDR) that ranges from 0 percent disabled to 100 percent; monthly payments range from $133 for a 10 percent disability to over $3,200 per month for a 100 percent disability.[54]

VA disability compensation is relevant to our analysis because military retirees who receive a CDR ranging from 10 percent to 40 percent experience a dollar-for-dollar offset of military retirement pay for the disability compensation received.[55] For retirees subject to offsets, VA disability payments do not change gross income, but they do increase after-tax income because VA benefits are not taxable.

Under the BRS, VA offsets will not apply only to monthly retirement payments, but to lump sum amounts as well. The BRS legislation explicitly states that "compensation benefits payable to a person under this title shall be reduced by the amount of any lump sum payment made to such person under section 1415 of title 10." This means that VA disability compensation payments will not be made to a retiree who exercises the lump sum option until the future point at which the amount of VA compensation payments the individual would have received based on his or her CDR equals the amount of the lump sum payment. To see the effect of the offset to lump sum payments, consider a retiree who has a 40 percent disability and is eligible to receive a disability payment of $700 per month. If this retiree was eligible for a $100,000 lump sum payment, this retiree would have to wait 12 years (= 100,000/(12*700)) from the point that disability compensation eligibility

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[53] Since the DoD Actuary data contain marital status but not the number of dependents, we cannot observe each retiree's exact number of exemptions. However, in our ACS military retiree cohort, married individuals have an average of 1.89 dependents while individuals in other marital statuses (mostly single) have an average of only 0.013 dependents. These data thus support the assumption of 1 exemption for non-married individuals and 3 exemptions for married individuals.

[54] For the full range of payments, see http://www.benefits.va.gov/compensation/resources_comp01.asp.

[55] For an explanation of offsets, see "How VA Disability Compensation Affects Military Retirement Pay," The Military Wallet, http://themilitarywallet.com/va-disability-compensation-affects-military-retirement-pay/. Importantly, veterans who have a CDR of 50 percent or above are not subject to offsets.

is established before receiving disability payments. During this period, the retiree effectively loses the tax advantage he or she would have received had the lump sum option in the BRS not been exercised and the individual took the annuity instead.

To account for VA offsets in the analysis, we first estimated the probability that each military retiree in the FY 2015 cohort would, at some point after separation from service, acquire a VA disability rating in the 10 percent to 40 percent range. These probabilities were based on a multinomial logit model estimated with the ACS data described above (see Appendix E for details). The ACS data indicate that about 32 percent of retirees will be subject to VA offsets and that another 38 percent will acquire disability ratings of 50 percent or more and not be subject to offsets. Retirees were simulated to be subject to a VA offset if a random draw from a uniform distribution was less than the predicted probability of offset.

To determine the lost tax advantage to each retiree subject to the VA offset, we needed the average VA disability compensation payment to retirees with 10 percent to 40 percent CDRs. Based on unpublished data on military retirees enrolled in the VA healthcare system provided to us by The Lewin Group, we calculated the average annual compensation payment to VA retirees with CDRs in the 10 percent to 40 percent range to be approximately $3,700. This average annual amount was then applied to the retirees simulated to be subject to offset to compute (1) the number of offset years and the present value at retirement of the lost VA tax advantage due to VA offset, (2) the reduction in the net value of the lump sum payment, and (3) the breakeven discount rate for retirees subject to offset. Since the present value of the lost tax advantage depends on the retiree's PDR and tax bracket, the present value of the lost tax advantage was computed on a retiree-by-retiree basis. However, because we did not have any data on the timing of entry into the VA disability system, we assumed, conservatively, a delay of three years from separation until VA system entry in the construction of the present value of the lost tax advantage.

As described in the following steps, if retirees subject to VA offsets fully anticipate their effects on the net lump sum amounts that they will receive if they exercise the lump sum option in the BRS, offsets will have the effect of raising the breakeven rate associated with their choices and reducing the likelihood that they will exercise the lump sum option.

4. Estimate Personal Discount Rates (PDRs) of New Retirees

The literature on PDRs has been reviewed in Appendix A. Appendix A makes clear that there is no single PDR or even distribution of PDRs, whether in the population of military retirees or in the civilian population. But the most recent study of the PDRs of military personnel (Simon, Warner, and Pleeter, hereafter SWP),[56] indicates that personnel approaching the retirement point are likely to exhibit fairly low PDRs, but also that there is significant variation in PDRs due to both observable and unobservable factors. The findings of this study were, in fact, in line with findings from analysis of questions related to the option to cash out the full second-career annuity found in the 2004 SOF survey discussed in Appendix A.

Because of the uncertainty about PDRs, our strategy is to first develop a base case distribution of PDRs that is consistent with these studies and use this distribution to obtain lump sum take rates, DoD retirement liabilities with and without the lump sum option, and the changes in those liabilities due to the lump sum option. We then repeat these calculations with different assumptions about the PDR distribution.

To develop a base case distribution of PDRs in the new retiree population, the SWP study data were used to obtain an equation for PDRs based on factors observable in both those data and the DoD Actuary data. As in the regression for income described earlier, these factors include controls for gender, age, marital status, education level, and race/ethnicity.[57] The coefficients on the controls for these factors in the PDR equation are also shown in Table D-1 of Appendix D. Each retiree is assigned a PDR based on that retiree's observable characteristics as well as on random factors. The details of this assignment process are discussed in Appendix D.

5. Estimate Lump sum Take Rates

As discussed in Step 2 on page B-3, lump sum cash-out amounts were constructed for each new retiree in FY 2015 based on the retiree's net annual retired pay under the BRS for discount rates ranging from 2.5 percent to 20.5 percent. If individuals are assumed to ignore (1) the tax consequences of the lump sum option or (2) the lost tax advantage due to potential VA offsets to disability compensation payments, the choice is simple: take the lump sum if the discount rate DoD uses to construct the lump sum option (symbolized by g) is less than the individual's PDR (symbolized by d). The lump sum take rate is the percentage of individuals for whom $g < d$. This assumption is likely to overstate the take

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[56] Curtis J. Simon, John T. Warner, and Saul Pleeter, "Discounting, Cognition, and Financial Awareness: New Evidence from a Change in the Military Retirement System," *Economic Inquiry* 53, No. 1 (January 2015): 318–34, doi: 10.1111/ecin.12146.

[57] The PDR equation does not include an explicit control for officer/enlisted status; however, the equation predicts higher PDRs for enlisted personnel, largely through the controls for level of education. Only 17 percent of enlisted retirees have completed at least a four-year college degree while over 93 percent of officers have completed at least a four-year degree and 62 percent have graduate degrees. Other sources of differences in the PDRs of officers and enlisted personnel include differences in distribution by marital status, race/ethnicity, and age at retirement.

rate because it is based on extreme myopia about the US tax system and ignorance of how differential taxation of the lump sum option will reduce the relative payoff to this option.

To understand how taxation is likely to affect the choice to take the lump sum option, we need to discuss how taxation affects the breakeven discount rate for the cash-out choice from the perspective of the retiree. Denote this rate by the symbol b. From the perspective of the retiree, b is the discount rate that equates the present value of the *after-tax* annuity payments the individual *forgoes* by selecting the lump sum option with the after-tax value of the lump sum payment. Appendix F establishes three propositions:

- First, if the marginal tax rate on the annuity payments forgone by taking the lump sum payment equals the marginal tax rate on the lump sum payment, then taxation has no effect on the breakeven discount rate. Why? Because taxation has reduced all current and future values proportionally. In this case, the discount rate the government uses to construct the lump sum payments equals the breakeven discount rate that the individual associates with the choice (i.e., $g = b$).
- Second, because of progressive federal income taxation, for many retirees the marginal tax rate on the lump sum will exceed the marginal tax rate on the forgone annuity payments (and our calculations so indicate). When this happens, the after-tax lump sum amount is reduced relative to the forgone future annuity amounts, thereby increasing the discount rate that equates the present value of the forgone annuity payments with the lump sum (i.e., $b > g$).
- Third, the effect of progressive taxation on the breakeven discount rate depends on the age of the retiree. Appendix D shows that b increases with age for any retiree, given the differential in taxation between the forgone annuity and the lump sum. That is to say, progressive taxation causes b to rise more relative to d the *older* the retiree. The reason for this is that the older the retiree, the more taxation takes away from the net lump sum amount the individual receives relative to the future income the individual forgoes. If individuals fully account for tax effects in making their lump sum payment choices, this age effect on b suggests that older individuals will be less likely to take the lump sum payments independent of any effect of age on PDRs.

There is a final relationship to note between b and g that is implied by the second proposition above: the difference between b and g declines as g increases. That is to say, the bigger the discount rate the government uses to construct the lump sum payments, the less the breakeven rate increases as a result of progressive taxation. This is simply due to the fact that the marginal tax rate on the lump sum payment is smaller, the smaller the payment.

Using equation (F-4) of Appendix F, b was calculated for each individual for each value of g ranging from 2.5 percent to 20.5 percent. Then, assuming full awareness of the tax implications of the lump sum option, we compute the after-tax lump sum take rate as the percentage of retirees for whom $d > b$. Note that this computation of the after-tax breakeven rate also accounts for the reduction in the net lump sum amount for retirees subject to VA offsets (with this reduction being the present value of the lost tax advantage on VA disability compensation payments over the time period required to recoup the lump sum payment).

6. Calculation of DoD Retirement Liability and Savings under Each Discount Rate Scenario

This step simply involves re-calculation of the present value of DoD's future retirement liability and the reduction in that liability from what it would have been without the lump sum option. To do these calculations, we (1) calculate DoD's future retirement liability for each retiree based on the option they select, (2) calculate the change in liability (which equals 0 if the individual chooses not to take the lump sum, and the difference between the liability without the cash-out option and the liability with the cash-out option if the individual chooses to cash out), and then (3) aggregate over individuals to obtain total DoD liability without the lump sum option and the change in liability due to the option. Because DoD's liability can never increase with the cash-out option, the DoD retirement liability will either remain the same or decrease. In the scenarios presented below, the change in DoD's retirement liability is presented as a positive number, i.e., as a saving.

B. Take-Rate Simulation Under Four Scenarios about the PDR Distribution

We executed the steps described above for four scenarios about the distribution of PDRs in the new retiree population. Figure B-1 shows the distribution of PDRs for Active Duty officer retirees and Active Duty enlisted retirees in the base case (Scenario 1).

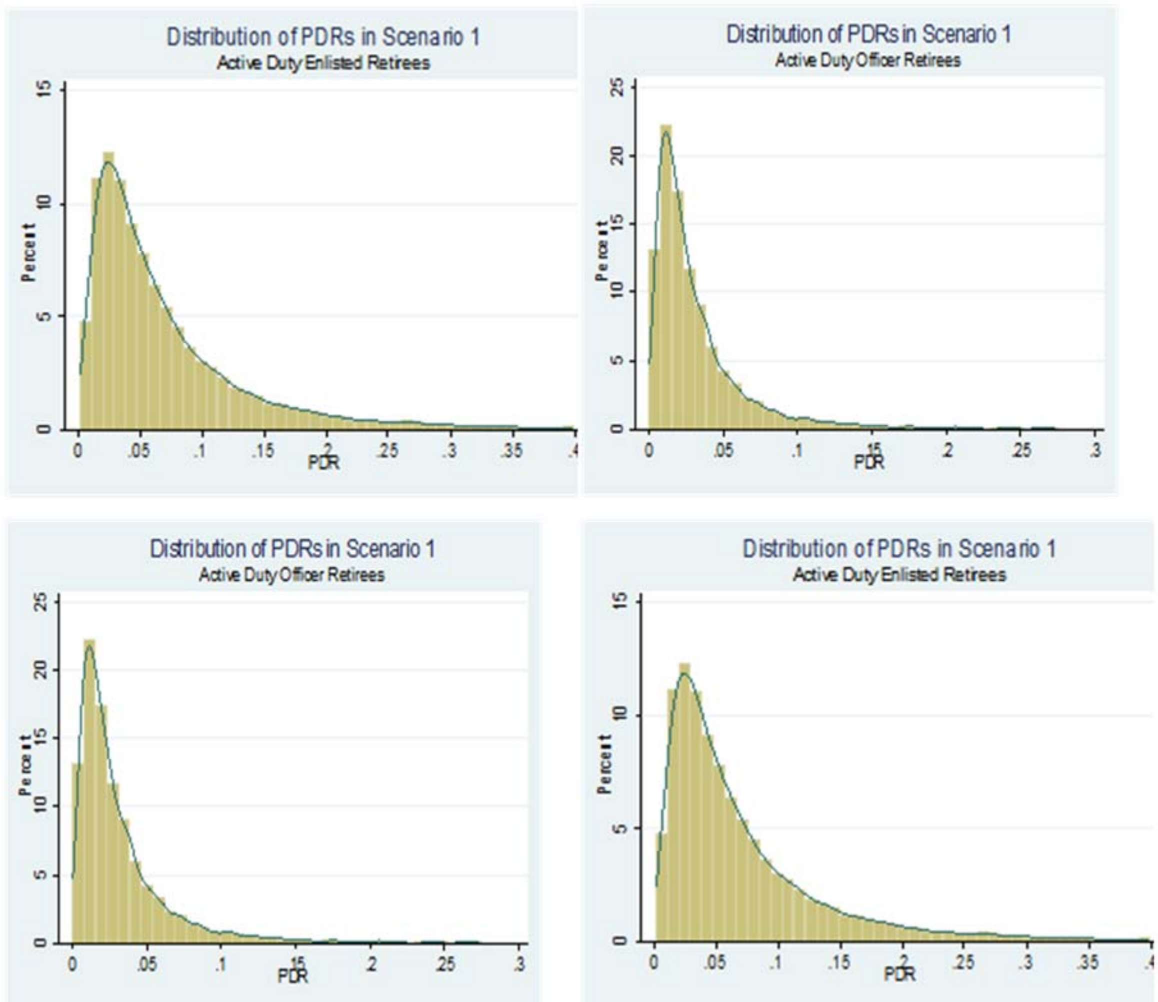

Figure B-1. Base Case PDR Scenarios

As Table B-1 shows, Scenario 1 has the lowest median and mean PDRs of the four scenarios. Consistent with the literature, officer PDRs are lower than enlisted PDRs. Owing to age differences, PDRs are generally lower for Reserve retirees than Active Duty retirees. Scenario 1 is designed to approximate the PDR distributions derived from REDUX behavior. Scenario 4 is designed to approximate the PDR distribution derived from Drawdown dehavior. Because the PDR distribution is left-skewed, mean (or average) PDR exceeds the median PDR.

Table B-1. Summary of Discount Rates in the Four Scenarios

Component	Personnel Category	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
		Median	Mean	Median	Mean	Median	Mean	Median	Mean
Active	**Enlisted**	0.057	0.079	0.074	0.103	0.096	0.132	0.123	0.170
	CO	0.025	0.035	0.033	0.044	0.042	0.059	0.054	0.073
	WO	0.045	0.062	0.059	0.078	0.076	0.106	0.097	0.133
Reserve	**Enlisted**	0.030	0.041	0.039	0.053	0.050	0.069	0.065	0.088
	CO	0.017	0.024	0.023	0.032	0.029	0.040	0.037	0.050
	WO	0.023	0.033	0.030	0.041	0.038	0.050	0.049	0.059
All		0.041	0.057	0.054	0.074	0.069	0.095	0.089	0.122

Notes: CO – commissioned officer; WO – warrant officer.

The marginal tax rate on the annuity, averaged over all retirees, is 0.155. For each discount rate that DoD uses to construct the lump sum amounts, Table B-2 shows the averages of the marginal tax rate on the lump sum amounts over all retirees and the after-tax breakeven rate. The average marginal tax rates on the lump sum amounts are significantly higher than the average marginal rate on the annuity payments, and the differential increases as the discount rate that DoD uses to construct the lump sum payments decreases.

Table B-2. Marginal Tax Rates and After-Tax Breakeven Discount Rates for Lump Sum Distributions

DoD Discount Rate (*g*)	Marginal Tax Rates	After-Tax Breakeven Rate (*b*)
0.025	0.248	0.042
0.035	0.247	0.053
0.045	0.245	0.063
0.055	0.244	0.074
0.065	0.242	0.084
0.075	0.240	0.094
0.085	0.238	0.105
0.095	0.237	0.115
0.105	0.235	0.125
0.115	0.234	0.136
0.125	0.232	0.146
0.135	0.231	0.157
0.145	0.230	0.167
0.155	0.229	0.177
0.165	0.228	0.188
0.175	0.227	0.198
0.185	0.226	0.209
0.195	0.225	0.219
0.205	0.224	0.230

Table B-3 shows the take rates we computed for each of the four scenarios. The columns labeled "BT" (before tax) show the estimated take rates assuming that retirees ignore tax and VA offset considerations when making their choices. The columns labeled "AT" (after tax) show take rates assuming that tax and VA offset considerations are accounted for. Under the base case assumption about the distribution of PDRs, 62 percent of all retirees exercise the lump sum option when tax effects are ignored, and only 36 percent exercise the option when tax and VA considerations are taken into account.[58] As expected, take rates decline as the DoD discount rate increases.[59]

[58] These take rates are across all retirees. Tables are available that show the take rates by status (commissioned officer, warrant officer, enlisted) and component (Active Duty retiree, Reserve retiree).

[59] These scenarios successively increase the median discount rate but do not change the percentage variation in discount rates (standard deviation of the distribution of the natural log of PDRs). Excursions are possible in which the spread in PDRs is increased. The effect would be to increase the take rate at higher values of ***g***.

Table B-3. Overall Before-Tax (BT) and After-Tax (AT) Take Rates by DoD Discount Rate (*g*) Used To Determine Lump Sum Amounts

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
g	BT	AT	BT	AT	BT	AT	BT	AT
0.025	62%	36%	71%	45%	79%	54%	86%	63%
0.035	49%	29%	59%	37%	68%	46%	77%	56%
0.045	39%	23%	49%	32%	59%	40%	68%	49%
0.055	32%	19%	42%	27%	51%	35%	61%	44%
0.065	26%	16%	35%	23%	45%	31%	55%	40%
0.075	22%	14%	30%	20%	39%	27%	49%	36%
0.085	18%	12%	26%	17%	35%	24%	44%	32%
0.095	16%	10%	23%	15%	31%	21%	40%	29%
0.105	13%	9%	20%	13%	27%	19%	36%	26%
0.115	12%	7%	17%	12%	24%	17%	33%	24%
0.125	10%	6%	15%	10%	22%	15%	30%	22%
0.135	9%	6%	14%	9%	20%	14%	27%	20%
0.145	8%	5%	12%	8%	18%	13%	25%	18%
0.155	7%	4%	11%	7%	16%	11%	23%	17%
0.165	6%	4%	10%	7%	15%	10%	21%	15%
0.175	5%	3%	9%	6%	13%	9%	20%	14%
0.185	5%	3%	8%	5%	12%	9%	18%	13%
0.195	4%	3%	7%	5%	11%	8%	17%	12%
0.205	4%	3%	7%	4%	10%	7%	16%	11%

C. Potential DoD Savings

Based on estimates of take rates that account for taxation, Table B-4 shows the DoD retirement liability under the BRS (in billions of dollars) for each scenario and DoD discount rate.[60] Without the cash-out option, the new retiree cohort's total liability, in present value terms based on a real DoD discount rate of 2.5 percent, would be $27.16 billion. If the government also uses this discount rate to compute the lump sum cash-out amounts, its liability does not change. The liability begins to decline as lump sum amounts are taken at higher values of the discount rate that DoD uses to construct the payments (*g*). The decline in liabilities is, of course, larger, the higher the take rates. Nevertheless, as Table B-5 shows more clearly, the reductions in the liability (that is, potential savings to DoD) are, in most cases, less than a billion dollars.

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[60] The numbers are DoD liabilities and do not account for tax revenues accruing to the US Treasury in each case. Furthermore, they are liabilities resulting from annuity payments and lump sum cash-outs and do not account for previous government contributions into the Federal Thrift Savings Plan (FTSP) on behalf of Service members.

Table B-4. DoD Retirement Liability by PDR Scenario Based on After-Tax Breakeven Rates, and Awareness of VA Offset Provisions

g	Scenario 1	Scenario 2	Scenario 3	Scenario 4
0.025	$27.16	$27.16	$27.16	$27.16
0.035	$26.94	$26.87	$26.81	$26.75
0.045	$26.82	$26.71	$26.59	$26.47
0.055	$26.77	$26.63	$26.46	$26.29
0.065	$26.75	$26.58	$26.39	$26.19
0.075	$26.75	$26.57	$26.37	$26.13
0.085	$26.77	$26.59	$26.36	$26.11
0.095	$26.79	$26.61	$26.38	$26.11
0.105	$26.82	$26.64	$26.40	$26.13
0.115	$26.84	$26.66	$26.44	$26.16
0.125	$26.87	$26.69	$26.48	$26.19
0.135	$26.89	$26.73	$26.51	$26.23
0.145	$26.92	$26.76	$26.55	$26.28
0.155	$26.94	$26.79	$26.58	$26.32
0.165	$26.96	$26.81	$26.62	$26.36
0.175	$26.97	$26.84	$26.66	$26.41
0.185	$26.99	$26.87	$26.68	$26.45
0.195	$27.00	$26.89	$26.72	$26.48
0.205	$27.01	$26.91	$26.75	$26.52

As can be seen in Table B-5 (shown by bolded amounts), savings are maximized at a Government Discount Rate (GDR) of 6.5 percent under Scenario 1, rising to 8.5 percent under Scenario 4. This means that if Scenario 1 pertains, a GDR higher than 6.5 percent reduces both savings to the government and the value of the lump sum payments to retirees. If Scenario 4 pertains, both government savings and retiree benefits fall at rates above 8.5 percent.

Table B-5. Savings by Scenario Based on After-Tax Breakeven Rates and Awareness of VA Offset Provisions (Millions)

g	Scenario 1	Scenario 2	Scenario 3	Scenario 4
0.025	$0	$0	$0	$0
0.035	$220	$284	$347	$412
0.045	$335	$446	$566	$685
0.055	$390	$532	$693	$864
0.065	**$406**	$575	$764	$971
0.075	$404	**$584**	$787	$1,029
0.085	$388	$572	**$796**	**$1,049**
0.095	$368	$550	$779	$1,047
0.105	$343	$522	$753	$1,028
0.115	$317	$495	$720	$1,003
0.125	$291	$464	$681	$968
0.135	$266	$432	$645	$932
0.145	$242	$401	$607	$883
0.155	$222	$371	$575	$838
0.165	$203	$345	$538	$794
0.175	$186	$315	$502	$752
0.185	$172	$290	$474	$711
0.195	$158	$271	$442	$676
0.205	$146	$251	$411	$640

Appendix C.
Summary Statistics about the FY 2015 Retiree Cohort and Calculations Related to the Analysis

This appendix provides some summary statistics about the FY 2015 retiree cohort and summarizes other calculations not shown in the main text.

Table C-1. FY 2015 Retiree Cohort Statistics

		All	Active	Reserve
Number in Cohort		48,653	33,905	14,748
Means	Age at Retirement	49.8	45.1	60.5
	Years of Service	26.4	22.2	36.1
Percents	Commissioned Officer	28.4	27.5	30.4
	Warrant Officer	3.3	3.9	1.9
	Enlisted	68.3	68.6	67.7
	Male	86.8	87.6	84.9
	Education < HS	0.5	0.3	1.1
	High School Equiv	1.9	1.0	4.0
	High School Diploma	33.6	31.1	39.3
	Some College	21.8	24.6	15.3
	College Graduate	20.5	18.7	24.5
	Graduate Education	21.6	24.2	15.6
	White Non-Hispanic	71.7	69.0	77.7
	Black Non-Hispanic	19.1	20.3	16.4
	Asian Non-Hispanic	4.7	5.8	2.1
	Other Non-Hispanic	1.5	1.4	1.6
	Hispanic Any Race	3.1	3.4	2.2
	Married	81.8	82.7	79.8
	Single	5.9	5.3	7.1
	Widowed or Divorced	12.2	11.9	12.8
	Other Marital Status	0.1	0.1	0.2
	Army	41.9	37.2	52.7
	Navy	18.9	20.2	16.0
	Air Force	31.6	32.6	29.3
	Marine Corps	7.6	10.1	2.1

Table C-2. Basic Calculations Involving Retired Pay under Modernized Military Retirement System

	All Retirees	Active	Reserve
Life Expectancy	82	81	84
Second Career	17	22	7
BRS Annuity	$24,549	$29,111	$14,061
Total Value of Retirement Payments[a]	$846,683	$1,060,689	$354,691
Present Value of Payments[b]	$558,206	$688,219	$259,313
Present Value of 2nd Career Payments[c]	$354,136	$466,132	$96,662

[a] Undiscounted and in 2015 dollars;

[b] Computed at 2.5 percent real discount rate; and

[c] Payments from age at retirement to age 67.

Table C-3. Average Lump Sum (LS) Amounts and Implied Tax Liabilities at Various DoD Discount Rates (g), All Retirees

g	Gross LS	Net LS	Federal Tax Liability	Tax as a Percent of Gross LS
0.025	$177,068	$132,403	$44,665	25.2
0.035	$162,780	$121,623	$41,158	25.3
0.045	$150,372	$112,375	$37,996	25.3
0.055	$139,540	$104,369	$35,171	25.2
0.065	$130,039	$97,388	$32,651	25.1
0.075	$121,666	$91,258	$30,407	25.0
0.085	$114,252	$85,840	$28,412	24.9
0.095	$107,659	$81,024	$26,635	24.7
0.105	$101,772	$76,723	$25,049	24.6
0.115	$96,493	$72,865	$23,629	24.5
0.125	$91,742	$69,389	$22,353	24.4
0.135	$87,450	$66,246	$21,204	24.2
0.145	$83,558	$63,392	$20,166	24.1
0.155	$80,018	$60,792	$19,226	24.0
0.165	$76,787	$58,415	$18,372	23.9
0.175	$73,829	$56,235	$17,594	23.8
0.185	$71,113	$54,231	$16,882	23.7
0.195	$68,613	$52,383	$16,229	23.7
0.205	$66,304	$50,675	$15,629	23.6

Appendix D. Simulation of Income and Personal Discount Rates

This appendix discusses how income and personal discount rates (PDRs) were constructed or simulated at the individual retiree level, for the purposes of analysis. Neither income nor PDRs are observable; therefore, they have to be inferred. To do this, we estimated the expected values of these variables for each retiree based on observable factors and then, for the purposes of analysis, we add a random error drawn from a distribution. This process will generate distributions of income and PDRs across the retiree population that contain variation arising from both observable and unobservable factors.

It is well known that the distribution of family incomes follows a log-normal distribution. The log-normal distribution restricts incomes to be 0 or positive and the distribution to be left-skewed, with many incomes in the lower part of the distribution and a long tail of incomes in the upper part. Evidence from Simon, Warner, and Pleeter[61] also indicates that PDRs follow a log-normal distribution.

Technically, if a variable Y follows a log-normal distribution, its natural logarithm—$\log(Y)$—follows a normal distribution with a mean μ and a standard deviation σ. Since the normal distribution is symmetric around the mean value μ, μ is also the median value of $\log(Y)$, with half of values of $\log(Y)$ lying below μ and half lying above μ. We can then write that $\log(Y) = \mu + \varepsilon$, where ε is the random deviation of $\log(Y)$ from its mean value μ. The random error ε follows the normal distribution with a mean of 0 and standard deviation of σ.

The variable $Y = \exp(\log(Y)) = \exp(\mu + \varepsilon)$. Since μ is the median value of $\log(Y)$, the median value of Y is given by $\exp(\mu)$. Furthermore, we may show that the mean (expected) value of Y is given by $E(Y) = \exp(\mu+\sigma^2/2)$. The mean value of Y thus exceeds the median value of Y, and the factor $\sigma^2/2$ shows the approximate percentage increase in the mean value over the median value. For example, if $\sigma = 0.5$, then the mean of Y will be approximately 12.5 percent higher than the median value. Larger random errors increase

61 Curtis J. Simon, John T. Warner, and Saul Pleeter, "Discounting, Cognition, and Financial Awareness: New Evidence from a Change in the Military Retirement System," *Economic Inquiry* 53, No. 1 (January 2015): 318–34, doi: 10.1111/ecin.12146.

the mean value of *Y* as well as its dispersion. The standard deviation of *Y* is given by SD(Y) = $E(Y)[\exp(\sigma^2) - 1]^{1/2}$.

The median value of log(*Y*) can be modeled as a function of observable factors. In this case, $\mu = X\beta$ where *X* denotes the set of factors that influence the median value of log(*Y*) and β denotes the set of coefficients (weights) applied to those factors. In our context, those factors include the retiree's age, gender, education level, marital status, and race/ethnicity. Because the model for *Y* is logarithmic, each coefficient shown in Table D-1 can be interpreted as percentage change in the median of *Y* due to the factor it weights.

Table D-1. Coefficients in Equations for Log-Income and Log-PDR

	Variable	Log-Income	Log-PDR
	Age	0.125	-0.037
	Age Squared	-0.001	
	Male	0.009	0.093
Education Group (Ref = Less than Some College)	Some College	0.109	-0.232
	College Degree	0.282	-0.758
	Graduate Degree	0.594	-1.313
Race/Ethnicity (Ref = White Non-Hispanic)	Black Non-Hispanic	-0.057	0.836
	Asian Non-Hispanic	-0.047	-0.081
	Other Non-Hispanic	-0.083	0.454
	Hispanic	-0.102	0.076
Marital Status (Ref = Other Marital Status)	Married	0.494	-0.030
	Single	-0.099	-0.605
	Intercept	7.693	-1.512
	Standard Deviation	0.542	0.800

Based on the coefficients in Table D-1, we predicted the median of log-income and the median of log-PDR for each retiree in the FY 2015 cohort. Then we assigned each retiree a value of log-income by drawing random errors from a normal distribution with a mean of 0 and a standard deviation equal to the estimated standard deviation of income (0.542) and adding that to the estimated median. We then obtained values of income by exponentiating this value. A similar procedure was followed to assign each retiree a PDR.

Appendix E.
Estimation of the Probability of a Service-Connected Disability and VA Offsets

Since 2008, the American Community Survey (ACS) has asked veterans about their Combined Disability Ratings (CDRs). In 2014, about 19.3 million individuals identified themselves to be military veterans and about 3.8 million said that they had Department of Veterans Affairs (VA) disability ratings, a number close to the actual 3.9 million compensation recipients reported by the VA.[62]

The ACS asks veterans about their Periods of Service (POS), with any active duty since the year 2000 being the most recent POS. We focus on veterans from this period (termed "recent veterans") who are between the ages of 35 and 59. Using all ACS data for the 2010–2014 period, Table E-1 summarizes the distribution of CDRs of all recent veterans in this age range and then distributions for non-retirees and retirees separately. Just over 20 percent of recent non-retirees had a service-connected disability, with 11.9 percent in the 10–40 percent range and 8.3 percent in the 50 percent+ range. A much higher percentage of the retirees have a CDR (70 percent), of which almost 32 percent were in the 10–40 percent range. The 38 percent of retirees with disability ratings is consistent with DoD Actuary data. Among retirees in the FY 2015 cohort, 31 percent were flagged as eligible for concurrent receipt of military retired pay and VA disability benefits at the 50 percent-plus level. This 31 percent represents individuals who retired in FY 2015 and had established VA disability ratings of 50 percent or more prior to retirement. The ACS data show a higher percentage of retirees with 50 percent+ ratings because some retirees will not acquire VA disability ratings prior to retirement. And, of course, we are using the ACS data to estimate the probability that a retiree will receive a VA disability rating in the 10–40 percent range because the DoD Actuary data contain no information about retirees who have, or might, establish ratings in this range.

[62] U.S. Department of Veterans Affairs, *FY14 Annual Benefits Report - Compensation Section*, October 20, 2015, http://www.benefits.va.gov/REPORTS/abr/ABR-Compensation-FY14-10202015.pdf.

Table E-1. Distribution of CDRs in the Recent Non-Retiree Cohort and in Recent Retiree Veteran Cohort

CDR	Non-Retiree	Retiree	All Recent Vets
10%–40%	11.9	31.8	13.9
50%+	8.3	38.0	11.3

The likelihood that a military retiree will have a VA disability rating—and in which range—can be determined by estimating a Multinomial Logit Model (MLM). The MLM is useful when the outcome to be analyzed has three or more discrete outcomes. This model has the form

$$P(Y = j) = \frac{\exp(X\beta_j)}{\sum_{i=1}^{J} \exp(X\beta_i)},$$

where Y denotes the outcome variable, j denotes the particular outcome, J denotes the number of outcomes, X is a vector of independent (control) variables that affect the outcome probabilities, and β_j is the vector of coefficients on the control variables. In our case, there are three outcomes (no VA disability rating, 10–40 percent rating and 50 percent+ rating).[63] As before, we include as controls variables that are common to both the ACS data and the DoD Actuary data.

Table E-2 shows MLM estimates. The coefficients do not themselves show how the probability of a given outcome changes due to a given variable. But those probability changes have been calculated at the mean values of the outcomes and are provided in the columns labeled "ΔP." To interpret, male retirees have a -0.045 lower probability than female retirees of being in the 50 percent+ category and a 0.040 higher probability of being in the 10–40 percent category. The change in the probability of having no CDR (not shown) is simply the negative of the sum of these two changes. Thus, male retirees have a 0.005 = -(-0.045+0.040) higher probability of not having a CDR. Probability changes due to other controls are interpreted similarly.

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63 It is conventional to choose one outcome as the base and set the coefficients associated with the base outcome equal to 0. The coefficients estimated for the other two outcomes are thus interpreted as showing the effects of a given variable relative to the base outcome. The coefficients themselves do not show probability changes due to a given variable, but may be used in the formula above to predict the probability of a given outcome.

Table E-2. Coefficients in a Multinomial Logit Model of Service-Connected Disability Rating

	50%+ CDR			10%–40% CDR		
Variable	**Estimate**	**Standard Error**	**ΔP**	**Estimate**	**Standard Error**	**ΔP**
Male	-0.128	0.064	-0.045	0.111	0.070	0.040
Education Group (Ref = Less than Some College)						
High School Graduate	0.671	0.533	0.105	0.423	0.498	0.000
Some College	1.031	0.531	0.166	0.611	0.496	-0.003
College Graduate	1.071	0.532	0.168	0.655	0.497	-0.007
Graduate Education	1.002	0.532	0.147	0.687	0.497	0.011
Race/Ethnicity (Ref = White Non-Hispanic)						
Black Non-Hispanic	0.515	0.057	0.111	0.110	0.062	-0.044
Asian Non-Hispanic	0.752	0.143	0.144	0.298	0.155	-0.042
Other Non-Hispanic	0.231	0.130	0.060	-0.027	0.140	-0.036
Hispanic	0.245	0.085	0.048	0.082	0.089	-0.014
Marital Status (Ref = Other Marital Status)						
Married	0.045	0.057	-0.005	0.126	0.060	0.022
Single	-0.466	0.116	-0.076	-0.259	0.120	-0.003
Age Group (Ref = 35–39)						
Age 40-44	-0.579	0.126	-0.125	-0.048	0.148	0.059
Age 45-49	-0.743	0.122	-0.188	0.154	0.143	0.126
Age 50-54	-0.898	0.123	-0.200	-0.004	0.144	0.106
Age 55-59	-0.882	0.131	-0.181	-0.076	0.152	0.082
Intercept	0.032	0.548		-0.728	0.521	
Sample Size	13,669					

Note: The base outcome is a 0 percent CDR or no CDR.

The estimated MLM was applied to the DoD Actuary data to calculate the probability that each retiree in the cohort would have a CDR in the 10 percent–40 percent range and thus be subject to a VA offset. As with previous simulated outcome, retirees were simulated to be subject to a VA offset if a random draw from a uniform distribution was less than the predicted probability of offset.

We also needed data on the average VA disability compensation payment to retirees with 10 percent–40 percent CDRs. Based on unpublished data on military retirees enrolled in the VA healthcare system provided to us by The Lewin Group, we calculated the average annual compensation payment to VA retirees with CDRs in the 10 percent–40 percent range to be approximately $3,700. This average annual amount was applied to the retirees simulated to be subject to offset to compute (1) the present value at retirement of the lost VA tax advantage due to VA offset, (2) the reduction in the net value of the lump sum payment due to the VA offset, and (3) the breakeven discount rate for veterans subject to offset. The present value of the lost tax advantage varies by retiree based on each retiree's PDR and tax bracket. Accounting for the VA offset raises the breakeven rate for those retirees and reduces the likelihood that the retiree will exercise the lump sum option.

Appendix F.
Breakeven Discount Rates with and without Taxation

In this appendix we derive the relationship between the discount rate that the Department of Defense (DoD) uses to construct lump sum payments (g) and the after-tax breakeven rate from the perspective of the retiree (b). To do this, we first define the following:

- A = the before-tax military retirement annuity;
- c = the lump sum cash-out rate (under the Blended Retirement System, 25 percent or 50 percent of A);
- n = number of second-career payments;
- P = present value of the stream of second-career payments;
- t_1 = the marginal tax rate on the retirement annuity; and
- t_2 = the marginal tax rate on the lump sum payment.

Because military retirement annuities are fully inflation-protected, A is constant over time in real terms. This is useful because we can use a simple formula for the present value of a fixed payment stream:

$$P = \frac{A}{g}[1 - (1 + g)^{-n}]. \tag{F-1}$$

The present value of the second-career annuity stream, P, is simply the annuity divided by the government discount rate, adjusted downward (by the term in brackets) for the fact that the income stream is finite. As the number of payments increases, the adjustment factor $[1 - (1 + g)^{-n}]$ approaches 1 in value. At the cash-out rate c, the before-tax lump sum cash-out amount L is given by cP, which equals

$$L = \frac{cA}{g}[1 - (1 + g)^{-n}]. \tag{F-2}$$

Now consider the effect of taxation. With taxation, and by selecting the lump sum option, the individual forgoes $(1 - t_1)cA$ of retired pay per period during the second career in return for the after-tax lump sum payment at retirement of $(1 - t_2)L$. The after-tax breakeven rate b is the discount rate that equates the present value of these two options:

$$(1 - t_2)L = \frac{(1-t_1)cA}{b}[1 - (1 + b)^{-n}]. \quad \text{(F-3)}$$

Therefore,

$$L = \frac{(1-t_1)}{(1-t_2)}\frac{cA}{b}[1 - (1 + b)^{-n}]. \quad \text{(F-4)}$$

Comparison of equations (F-2) and (F-4) makes it clear that when the marginal tax rates on the current lump sum and the future forgone annuity payments are equal, the breakeven discount from the perspective of the retiree will be the same as the discount rate that DoD uses to construct the lump sum payment ($b = g$).

With progressive taxation, it is likely to be the case that t_2 exceeds t_1. When this happens, the ratio $\frac{(1-t_1)}{(1-t_2)}$ will exceed 1 in value, implying that the discount rate b that solves equation (F-4) will increase in value. This is easiest to see in the case where n is infinite and the adjustment factor $[1 - (1 + g)^{-n}]$ equals 1 in value. In this case, $L = \frac{(1-t_1)}{(1-t_2)}\frac{cA}{b}$. However, from equation (F-2), $L = \frac{cA}{g}$. Setting these equations equal to each other and solving, we have

$$b = \frac{(1-t_1)}{(1-t_2)}g. \quad \text{(F-5)}$$

When the ratio $\frac{(1-t_1)}{(1-t_2)}$ exceeds 1 in value, b will exceed g. Furthermore, since the tax ratio increases with the difference in tax rates, the difference between b and g increases with the difference in tax rates.

Finally, consider the effect of the length of the second career on b. Rearranging equation (F-4), the breakeven discount rate b solves the equation

$$\frac{b}{[1-(1+b)^{-n}]} = \frac{(1-t_1)}{(1-t_2)}\frac{cA}{L}. \quad \text{(F-6)}$$

It is clear from equation (F-6) that as n increases, the denominator of equation (F-6) will increase in value. But because the right-hand side of equation (F-6) is fixed in value, the value of b that solves this equation must decrease in value to offset the effect of the increase in n. This implies that retirees who face long second careers will have lower breakeven rates than retirees with shorter second careers. An implication of this is that Reserve retirees, who usually begin drawing retired pay at age 60, will have higher breakeven rates (and therefore be less likely to exercise the lump sum option) than Active Duty personnel retiring in their 40s.

Finally, we make a technical point about solving for the after-tax breakeven rate. Without the cash-out option, the discounted present value of the future military retirement stream was computed as

$$PV = \sum_{t=mra}^{110} \frac{s_t A}{(1+r)^{(t-mra)}}, \tag{F-7}$$

where r is the real discount rate that the DoD Actuary applies to future retirement payments, mra is the military retirement age (or age at which retirement payments begin), and s_t is the probability that the retiree will still be alive at each future age t (which is conditional on retirement age). That is to say, our calculations accounted for survival from age at retirement to each future age (up to age 110, at which s_{110} is effectively 0).

With the cash-out option, a retiree's total future liability to DoD is the present value of future retirement payments plus the immediate lump sum payment. To calculate the present value of the retirement payments, A is replaced in equation (F-8) by $(1\text{-}c)A$ for ages less than 68. Then the lump sum payment with the cash-out option is computed as

$$L = \sum_{t=mra}^{67} \frac{s_t cA}{(1+g)^{(t-mra)}}, \tag{F-8}$$

where L is constructed based on the discount rate applied to the annuity payments forgone because of cash-out.

By accounting for survival, the value of L given by equation (F-8) will be smaller than the value of L given by equation (F-2), which assumes certain survival.[64] (If survival was certain (all $s_t = 1$), equations (F-2) and (F-8) would give the same value of L.) Equation (F-4) can still be used to derive the breakeven rate by first computing the "annuity equivalent" of the lump sum amount given by equation (F-8), which is given by solving equation (F-2) for A based on the amount L given by equation (F-8) and then using equation (F-4) to solve for b. The value of A given by this process will be somewhat smaller than the actual retirement annuity and will account for the fact that survival from the age of retirement to age 67 is not certain.

[64] Based on DoD Actuary data, an enlisted retiree at age 40 has an 87 percent chance of living to age 67, while an officer retiree has a 93 percent chance. These percentages will increase with the age at retirement.

Appendix G.
Technical Analysis – Retention Effects

An important remaining question is the extent to which the lump sum option in the Blended Retirement System (BRS) will affect military retention patterns. Furthermore, it is important to know how sensitive retention will be to the Department of Defense (DoD) discount rate. The lump sum option will have a larger effect on retention patterns at lower discount rates. Again, this is because the lump sum payments will be bigger, and hence more attractive, at the lower DoD discount rate. The analytical question, then, is whether the lump sum option will pull more significantly more personnel to the 20-year retirement vesting point because of the availability of immediate, sizeable cash payments and whether the availability of such payments will push more personnel out shortly after they reach that point.

This chapter describes an analysis of the potential effects of the lump sum option on enlisted and officer retention. It first describes the model used for the analysis and then predicted retention effects based on three different scenarios about the personal discount rates (PDRs) of military members.

A. Modeling Retention Decisions

1. Background

The Dynamic Retention Model (DRM), first developed by Glenn Gotz and John McCall at the RAND Corporation, has become the gold standard for analysis of the military compensation system.[65] More recent examples of development of, or analysis with, the DRM include the work of Asch and Warner; Daula and Moffitt; Asch, Hosek, Mattock, and Panis; Mattock, Asch, Hosek, Whaley, and Panis; and Asch, Mattock, and Hosek.[66]

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[65] G. Gotz and J. McCall, *A Dynamic Retention Model of Air Force Officer Retention: Theory and Estimation*, R-03028-AF (Santa Monica, CA: The RAND Corporation, 1984), http://www.rand.org /pubs/reports/R3028.html.

[66] B. Asch and J. Warner, *A Theory of Military Compensation and Personnel Policy* (Santa Monica, CA: The RAND Corporation, 1994), https://www.rand.org/pubs/monograph_reports/MR439.html; B. Asch and J. Warner, *A Policy Analysis of Alternative Military Retirement Systems* (Santa Monica, CA: The RAND Corporation, 1994), http://www.rand.org/pubs/monograph_reports/MR465.html; B. Asch and J. Warner, "A theory of compensation and personnel policy in hierarchical organizations with application to the U.S. military," *Journal of Labor Economics* 19, No. 3 (July 2001): 523–62, doi: 10.1086/322072; T. Daula and R. Moffitt, "Estimating dynamic models of quit behavior: The case of military reenlistment," *Journal of Labor Economics* 13, No. 3 (July 1995): 449–523, http://www.jstor.org/stable

This section provides an overview of the model and its application to the lump sum option in the BRS. Additional detail is provided in Appendix H.

The purpose of a retention model is to predict the period-by-period retention decisions of a cohort of military personnel from the entry point through the final period of service and derive the fraction surviving to each potential year of service (YOS). To do this, the model should have two desirable properties. One property is that the predictions should be based on a relatively sparse set of assumptions that do not depend on the particular structure of the compensation system. That is to say, to be useful the model must be able to predict retention across compensation regimes and not be dependent on the observed (historical) system as a starting point for predictions. The other property is that the model should be consistent with rational economic behavior. This means that individuals make decisions that maximize payoffs based on the information available at that time. This information includes expectations about promotion, future compensation in both the military and civilian sectors, and knowledge about how likely it is that random events will to cause them to leave at each future retention decision point. The DRM has become the gold standard in retention modeling because it embodies these properties.

2. Overview of the Dynamic Retention Model

When military personnel make retention decisions, they must evaluate the payoffs to the many future career paths they might follow in the future. The possible career paths include (1) all the possible promotion paths they might follow, and (2) all of the possible stay-leave sequences they might follow. The number of possible promotion paths and stay-leave sequences is potentially large. Furthermore, they are not known with certainty, but are probabilistic. At any given decision point, the probabilities of all possible paths must sum to 1, but the individual cannot be sure of any of them. But if the individual knows the probability of (1) promotion to each possible rank at each possible future YOS point, and (2) separating at each future YOS point (which is conditional on rank at that point), the

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/2535153; B. Asch et al., *Assessing Compensation Reform: Research in Support of the 10th Quadrennial Review of Military Compensation* (Santa Monica, CA: The RAND Corporation, 2008), http://www.rand.org/content/dam/rand/pubs/monographs/2008/RAND_MG764.pdf; M. Mattock et al., *Towards Improved Management of Officer Retention: A New Capability for Assessing Officer Retention*, DRR-5184-OSD (Santa Monica, CA: The RAND Corporation, 2010), http://www.rand.org/pubs/research_reports/RR764.html; and B. Asch, M. Mattock, and J. Hosek, *Reforming Military Retirement: Analysis in Support of the Military Compensation and Retirement Modernization Commission*, RR 1022 (Santa Monica, CA: The RAND Corporation, 2015), http://www.rand.org/content/dam/rand/pubs/research_reports/RR1000/RR1022/RAND_RR1022.pdf. See J. Warner and B. Asch, "The economics of military manpower," in *Handbook of Defense Economics Volume 1*, ed. K. Hartley and T. Sandler (Amsterdam: Elsevier, 1995), 347–98, doi: 10.1016/S1574-0013(05)80015-8; and B. Asch, J. Hosek, and J. Warner, "The new economics of manpower in the post-Cold War era," in *Handbook of Defense Economics Volume* 2, ed. T. Sandler and K. Hartley (Amsterdam: Elsevier, 2007), 1075–1138, doi: 10.1016/S1574-0013(06)02032-1, for a survey of military retention models that have been used in the past and comparisons with the DRM.

individual can form an expectation of the payoff to remaining in service. This expectation will of course make use of all information available at the time of the decision, including current and future military compensation, future military retired pay and other forms of compensation now and in the future (e.g., retention bonuses). The DRM is the most computationally efficient way to evaluate all of the possible future career paths and their expected payoffs and use that information in the current retention decision.

At each retention decision point in the DRM, the individual computes the Expected Return to Staying (ERS) and the Expected Return to Leaving (ERL). ERS is the expected present value of the return (payoff) to staying. It depends on the factors listed in the left-hand column of Table G-1. In computing ERS, decision makers are assumed to be aware of the fact that at each future decision point random shocks to the payoffs to staying and leaving may induce them to leave. The actual values of future random shocks are unknowable, but the individual can form an expectation of the probability that future random shocks will induce them to leave if the individual knows the probability distribution of those shocks. Based on this knowledge, and expectations about future promotion probabilities, the decision maker mentally constructs ERS as a weighted average of the payoffs to all future military career paths, the weights being the probabilities of following those paths. Once the decision maker has evaluated ERS, they evaluate ERL, which is simply the present value of already vested military retirement benefits plus the expected present value of future civilian earnings.

The current period retention decision depends not only on ERS and ERL, but random shocks to those expected values, denoted here by rs_m and rs_c, respectively. These random shocks capture individual-specific, unobservable factors not accounted for by ERS and ERL (e.g., sickness in the family, spouse does not like next assignment location, etc.). These shocks are assumed to be period-specific and not correlated with shocks that the individual might have experienced in the past or will in the future. The individual is assumed to stay if $ERS + rs_m > ERL + rs_c$.

Table G-1. Factors Involved in the Expected Returns to Staying in Service, Leaving Service, and the Retention Decision

Expected Return to Staying (ERS)	Expected Return to Leaving (ERL)
Current Active Duty pay in current rank	The present value of future civilian earnings if leave now
Active Duty pay in each future period (by rank)	The present value of retired pay if leave now in current rank
Probability of promotion to each possible rank in each future period	
The present value of retired pay if leave after each future period (by rank)	
The present value of civilian earnings if leave after each future period	
Tastes for service (τ)	
Distribution of random shocks to future retention decisions	
The Retention Decision: Remain in service if ERS + rs_m > ERL + rs_c	
The present values that enter ERS and ERL depend on the individual's PDR.	

3. Taste Heterogeneity and Its Implications

A key factor entering ERS is the individual's "taste for service." This factor, denoted by τ, measures the value that the individual places on the non-pecuniary aspects of military service versus civilian life. A positive value of τ indicates that the individual prefers military service to civilian life, while a negative value indicates the opposite.[67] Individuals are assumed to learn their taste for service during the initial period of service and that it does not change thereafter. There is substantial variation in tastes for service among service personnel—what economists refer to as *taste heterogeneity*. Evidence for this statement is provided by the many empirical studies showing that retention is somewhat, but not highly, responsive to increases in military compensation.[68]

The fact that tastes are heterogeneous has several important implications. The first is that there will be *sorting on tastes* as personnel progress through a career. Sorting occurs

[67] In a one-period model, τ can be thought of as the military-civilian wage differential required to make the individual indifferent between military service and civilian life. A value of τ of -$10,000 implies that military pay would have to exceed the individual's civilian wage opportunity by $10,000 for them to be indifferent between the military and civilian sectors.

[68] See Warner and Asch, "The economics of military manpower," and Asch, Hosek, and Warner, "The new economics of manpower," for surveys of this literature. If everyone had the same tastes, everyone would stay if the military-civilian pay differential exceeds –τ and everyone would leave if the differential is less than –τ. Equality of tastes (taste homogeneity) thus implies a high degree of sensitivity of retention to changes in compensation. As the degree of taste heterogeneity increases, retention becomes less sensitive to changes in military compensation.

because, all else being the same, low-taste individuals are more likely to leave than high-taste individuals. A consequence of sorting is that there is a natural tendency for retention to rise with YOS as the low-taste individuals leave and the high-taste individuals stay. An implication of sorting is that the average of τ among those who stay will be higher than the average in the whole cohort at the given decision point.

The second implication of taste heterogeneity is that retention rates at different career points are not independent of one another. If, for example, a bonus at the first reenlistment point induces personnel to stay who would have left otherwise, retention at the second reenlistment decision point will decline due to the fact that those induced by the bonus are less likely to stay for a second time than those who would have remained without the bonus.

A third implication of taste heterogeneity is that changes to the structure of the compensation system affect high-taste and low-taste personnel differently. Because high-taste (high τ) individuals have higher probabilities of staying in each future period than low-taste (low τ) individuals, high-taste individuals place larger weights on payoffs involving long military careers and smaller weights on payoffs involving shorter careers compared to the low-taste individuals. High-taste individuals are thus more affected by a pay change occurring at some distant career point (e.g., a change in the retirement system) and low-taste individuals are more affected by a pay change at some near-term point (e.g., a retention bonus). Stated differently, future compensation is discounted not only by a pure time factor (the PDR), but by the probability of being in service long enough to receive the future compensation.

B. Application of the DRM to the Lump Sum Option in the BRS

To conduct a retention analysis of the lump sum option in the BRS, we adapted the simulation version of the DRM developed by Asch and Warner (see footnote 66, page G-1).[69] The key difference between this version of the model and the version that RAND has recently used for various compensation analyses (see footnote 66, page G-1 for references to Asch et al. (2008); Mattock et al. (2010); and Asch, Mattock, and Hosek (2015)) is that the RAND model is based on a single PDR for all personnel.[70] An implication of the lack of PDR heterogeneity is that everyone will be predicted to take the lump sum option in the BRS or no one will, depending upon whether the discount rate the

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69 The model is coded in the Interactive Matrix Language (PROC IML) of the Statistical Analysis System (SAS).

70 The RAND model of course has advantages compared to this model. It incorporates Active to Reserve flows and is able to estimate the effects on Reserve (Active) retention of changes in Active (Reserve) compensation. It furthermore is able to perform analysis of transitions from one retirement system to another, whereas the version used here is capable only of steady-state analysis. Finally, the RAND model contains a cost module capable of computing Active force outlays and retirement liabilities, something not attempted here.

government uses to construct the lump sum payments is less than the PDR or greater. Introduction of variable PDRs permits estimation of take rates as well as the effect of the lump sum option on retention, both before and after retirement vesting.

In the simulation model used for this analysis, a cohort of N entrants enters service and serves for an initial term of service before it begins to make voluntary retention decisions. To reflect reality, a certain fraction of the entry cohort is lost to attrition in each YOS prior to the individual's expiration of term of service (ETS) year.[71] Those who survive to the initial ETS year make voluntary retention decisions according to the model structure discussed in the previous section. Individuals who stay continue through additional terms of service and make voluntary retention decisions at the completion of those terms. As before, some non-ETS losses occur during those terms.

Individuals who complete three YOS are randomly assigned a rank in YOS 4 based on the historical (FY 2001–2009) distribution of personnel in YOS 4.[72] We choose to initialize ranks at YOS 4 because that is the minimum YOS at which retention decisions begin to be made. The rank assignment process guarantees that the rank distribution of personnel at YOS 4 will conform to the historical distribution at that point. Once the initial rank assignment has been made, individuals who remain in service are promoted, or not promoted, in each future YOS based on historical (FY 2001–2009) promotion rates by rank and YOS.[73]

1. Distributional Assumptions

As discussed in the previous section, the model allows for heterogeneity of tastes, PDRs, and civilian earnings opportunities. Each member of the entry cohort is thus assigned a taste factor, a PDR, and a stream of civilian earnings based on random draws from normal distributions. The key parameters of these variables are as follows:

- **Tastes**. Tastes are learned during the course of the initial period of service and are assumed to follow a normal distribution with mean μ_τ and standard deviation

[71] The fraction lost to attrition in each of the first two years is based on historical annual loss rates in those years. Thereafter, losses of personnel not at the ends of enlistment contracts of obligations are set at levels explained below. To generate losses in the model, each individual is assigned a random draw from a uniform distribution (where values ranging from 0 to 1 are equally likely) and declared to be an attrition loss if the random draw is less than the historical attrition rate. This procedure ensures that the losses in the model will approximate the historical loss rate. As cohort size N increases, losses simulated in the model will converge to the historical rate.

[72] Rank distributions by YOS for FY 2001–2009 were constructed from Defense Manpower Data Center (DMDC) Active Duty Master File extracts located at the Institute for Defense Analyses (IDA). Distributions were constructed for enlisted personnel and commissioned officers by Service and for DoD. The analysis is based on the all-DoD distributions.

[73] Again, DMDC Active Duty Master File extracts were used to construct promotion rates from one rank to the next by YOS.

σ_τ. Members of the entry cohort are assigned a taste factor based on random draws from a normal distribution with mean μ_τ and standard deviation σ_τ.

- **Personal Discount Rates**. The PDR (symbolized here by ρ) is assumed to follow a log-normal distribution. A log-normal distribution is selected because it has been found to be a distribution that well describes the PDRs of military personnel.[74] Since the PDR itself is log-normal, its natural logarithm—$ln(\rho)$—follows a normal distribution whose mean and standard deviation we denote by the parameters μ_ρ and σ_ρ, respectively. The exponential of μ_ρ—$exp(\mu_\rho)$—gives the median PDR, and the quantity $\exp(\mu_\rho+0.5\sigma^2_\rho)$ gives the mean value of the PDR. The mean value of the PDR exceeds the mean value due to the left-skewness of the log-normal distribution; furthermore, the difference between the median PDR and the mean PDR increases with the standard deviation of $ln(\rho)$.
- **Post-Service Earnings**. Each entrant is assigned a post-service earnings function that allows the individual's post-service lifecycle of earnings from separation to retirement at age 65 to depend on the number of years of military service, the number of years of post-service labor market experience and a random factor that varies by individual. The parameters of this function are selected from myriad studies of lifecycle earnings. Importantly, as Goldberg and Warner established,[75] a year of military experience does not contribute as much to future post-service earnings as a year of civilian experience. For example, an individual who departs from military service at age 40 will not have the same expected post-service earnings at age 41 as an individual who departs at age 25 and has accumulated 16 years of civilian experience. The parameters of the post-service earnings function are set reflecting this fact. An implication is that the entrants account for the post-service earnings consequences of decisions to remain in service. Earnings heterogeneity is introduced through the random error in the earnings function, which is assumed to be normally distributed with mean 0 and standard deviation σ_c. The value of this parameter is set in accordance with estimates from past studies.
- **Random Shocks to Expected Returns**. As indicated in Table G-1, retention decisions are affected by random shocks to ERS and ERL. In accordance with

[74] John T. Warner and Saul Pleeter, "The Personal Discount Rate: Evidence from Military Downsizing Programs," *American Economic Review* 91, No. 1 (March 2001): 33–53, http://www.jstor.org/stable/2677897 (hereafter WP); and Curtis J. Simon, John T. Warner, and Saul Pleeter, "Discounting, Cognition, and Financial Awareness: New Evidence from a Change in the Military Retirement System," *Economic Inquiry* 53, No. 1 (January 2015): 318–34, doi: 10.1111/ecin.12146 (hereafter SWP).

[75] M. Goldberg and J. Warner, "Military experience, civilian experience and the earnings of Veterans," *Journal of Human Resources* 22, No. 1 (Winter 1987): 61–81, doi: http://www.jstor.org/stable/145867.

the technical discussion in Appendix I, it is assumed that these random shocks follow an extreme value distribution with standard deviation *s*.

- **Simulation Sample Size**. Each time the simulation model is run, random draws from three different normal distributions are made to assign tastes, PDRs, and civilian earnings to cohort entrants, and at each retention decision point random draws are made from extreme value distributions to shock their retention decisions. Because the random draws change from run to run, retention rates and the fraction of entrants surviving to each YOS will vary from run to run even under the same compensation system. But due to the law of large numbers, retention and survival rates will stabilize from run to run as the number of individuals in the entry cohort increases. We found that survival rates were very stable from run to run with an entry cohort of 30,000. All simulations shown below are based on that cohort entry size.

2. Calibration of Model Parameters

In order to run the simulation model, the key distributional parameters identified above must be set (calibrated). The parameters of the civilian earnings function are set based on estimates from the labor economics literature. Then, beginning with assumptions about the PDR distribution parameters, the parameters of the taste and random shock distributions are calibrated so that the fraction of the entry cohort that is predicted to remain in service to various YOS points mimics actual historical survival rates as closely as possible.[76] As shown below, the calibrated officer and enlisted models do a good, although not perfect, job of mimicking actual survival. Possible reasons for the deviations between actual and predicted survival rates are discussed below.

One caveat is that the model parameters are not independent of one another. To mimic actual survival when one parameter is changed, other parameters require adjustment as well. We chose not to do that. Rather, we chose to calibrate the model to actual survival for a base case assumption about the PDR distribution and then vary the PDR distribution holding other parameters constant. This means that predicted survival patterns under the current compensation system will not be exactly the same for different assumptions about the PDR distribution. However, the differences in predicted survival patterns are not large across the PDR scenarios simulated below. Therefore, within a given assumption about the PDR distribution, the model will show essentially the same effect of the lump sum option

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[76] Rather than calibrate taste and shock distribution parameters, RAND researchers estimate these parameters econometrically using panel data from various past entry cohorts and the estimation procedure described in Mattock et al., *Towards Improved Management of Officer Retention*. Because many features and assumptions of their model differ from the model being implemented here, including assumptions about PDRs, civilian earnings functions, and frequency of retention decision-making, their estimates are not useful here.

under the BRS (compared to the no lump sum option) as it would have shown with a closer calibration to the historical survival pattern.

Several assumptions were made in our calibration analysis:

- **Military Compensation**. The model uses military Basic Pay (BP) and Regular Military Compensation (RMC) tables as inputs, which are dimensioned by rank and YOS. We used the January 2015 BP and all-cash RMC tables.
- **Federal Thrift Savings Plan**. Personnel who enter service under the BRS will be enrolled in the Federal Thrift Savings Plan (FTSP) and will receive an automatic DoD contribution of 1 percent of BP. Personnel will also be eligible to contribute up to 5 percent of BP and receive matching DoD contributions. As a result, individuals and DoD, together, may contribute up to 11 percent of BP into FTSP. The model allows each individual to make an annual decision about whether to make individual contributions into FTSP at each YOS.

  To make this decision, the individual compares their PDR with $m*r$, where r is the market return to a dollar invested in FTSP and m is a multiplier to the market return arising from government contributions. For example, consider an individual who is age 22. If the market return is 5 percent and the individual and the government each contribute \$1 to the individual's FTSP, that \$2 investment will be worth \$12.16 at age 60 (the first year the individual can make FTSP withdrawals without tax penalties). The individual receives a 7 percent return on their individual contribution (since $\$12.16^{(1/(60\text{-}22))} – 1 = 0.07$). Thus, $m*r = 0.07$, implying that $m = 1.4$. The multiplier m rises with age, indicating that as personnel age they are more likely to reach the threshold at which PDR $< m*r$. Furthermore, individuals will not stop making individual contributions once they have begun. Voluntary contributors are assumed to contribute at the maximum rate.[77]

  A key assumption related to FTSP is the market rate of return to contributions in the plan. We assume a 5 percent real rate of return to the plan. This is a realistic average real rate of return for funds invested for long periods of time in a balanced portfolio of assets.

Two key assumptions relate to the frequency of voluntary retention decisions and non-ETS attrition:

- **Contract Terms**. As in the actual case, individuals are not free to make voluntary retention decisions every year, only at the ends of contracts. Lacking

[77] Of course, when modeling the BRS, individuals making voluntary FTSP contributions have their total annual Active Duty compensation reduced by 5 percent of basic pay to account for the fact that the individual does not have immediate access to their contributions.

data on actual contract lengths, we make a set of simplifying assumptions about them. In the case of enlisted personnel, the YOS interval prior to YOS 20 is divided into four intervals (Zone A = YOS 3–6; Zone B = YOS 7–10; Zone C = YOS 11–14, and Zone D = YOS 15–19) and individuals make one voluntary retention decision per zone. The retention decision zones are set this way because the first three zones correspond to the YOS intervals DoD has established for the payment of first-term, second-term, and third-term reenlistment bonuses, and individuals are eligible for only one bonus payment per zone. It is therefore natural to assume that the individuals make one voluntary retention decision per zone. The exact year at which an individual makes a voluntary retention decision in each zone is randomized on the basis of a uniform distribution. Individuals who survive to the 20-year point and become eligible for retired pay are assumed to be eligible to make a voluntary retention decision every year thereafter.

  Officer term lengths are treated somewhat differently. In the model, officer entrants are randomly assigned initial obligations of 4, 5, or 6 years and are then assumed to make a voluntary retention decision every three years thereafter in lockstep fashion. Decisions are assumed to be made at three-year intervals because officers are typically rotated from one assignment to another at such intervals. This allows a voluntary retention decision to be partly based on whether the officer desires the new assignment and location or not (and is part of the random errors to retention decisions). As in the enlisted case, officers are assumed to make retention decisions annually once they reach the 20-year mark.

- **Non-ETS Attrition**. As stated earlier, attrition in the first two YOS in the case of enlisted personnel, or first three YOS in the case of officers, is based on historical loss rates in those years. After YOS 2 (enlisted personnel) or YOS 3 (officers), individuals not at ETS are simulated to leave at an expected rate of 2.5 percent. This reflects losses arising from death, disability, and other factors.

3. PDR Scenarios

We conducted retention analyses for three scenarios involving PDRs. The median and mean PDRs in each of these scenarios is summarized in Table G-2. In the low-PDR scenario, the median PDR for officers was set at 3 percent and the median PDR for enlisted personnel was set at 6 percent. In the intermediate-PDR scenario, the median officer PDR was set at 6 percent and the median enlisted PDR was set at 9 percent. In the high-PDR scenario, the median officer PDR was set at 9 percent and the median enlisted PDR was set at 12 percent. All scenarios assumed a standard deviation of log-PDR of 0.8.

Table G-2. Historical Annual Continuation Rates Compared to Model Fits under Current Compensation System

	Enlisted				Officer			
YOS Interval	Historical	Low PDR	Intermed PDR	High PDR	Historical	Low PDR	Intermed PDR	High PDR
3–6	79.3	80.2	81.3	82.5	88.8	88.4	88.8	88.8
7–10	87.6	87.7	87.6	88.0	92.5	93.3	92.6	91.8
11–14	94.1	93.3	92.5	91.9	95.2	94.9	94.3	93.8
15–19	98.1	97.2	96.1	95.7	97.2	96.6	96.0	95.7
20–23	73.4	73.7	72.9	73.4	86.1	83.1	80.1	77.8
24–26	73.6	91.1	88.6	88.4	84.5	83.5	80.0	77.3
27–29	71.1	73.1	72.3	73.8	79.4	73.2	76.0	72.7

This assumption about the variation in PDRs is incorporated into the graphs of the PDR distributions in Figure G-1.

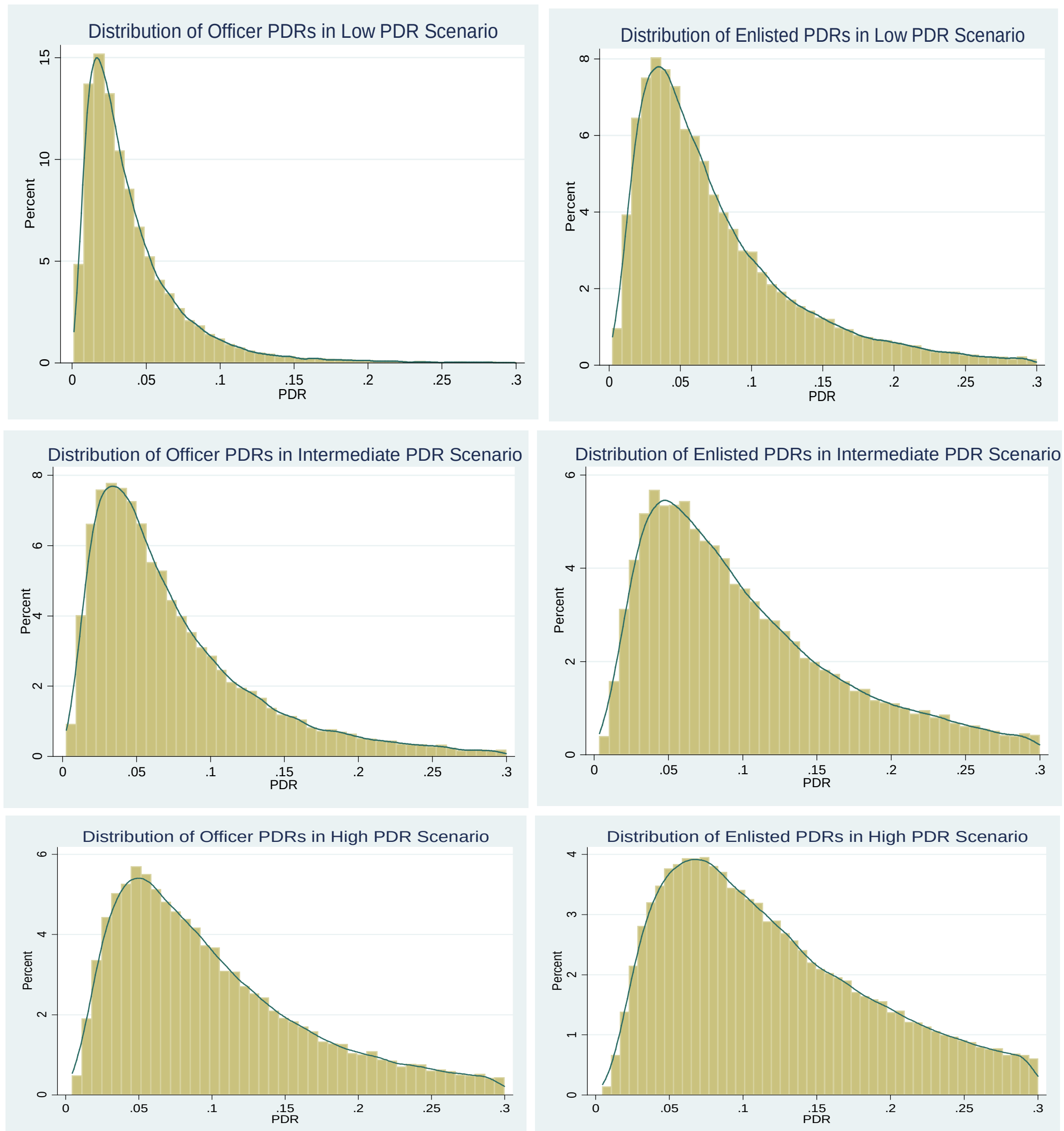

Figure G-1. PDR Distributions for the Three Scenarios

The low-PDR scenarios are consistent with the PDR distributions for military personnel derived from analysis of choices that military personnel have made about whether to remain under the High-3 retirement system or take a $30,000 Career Status Bonus at the 15-year mark and remain under the REDUX retirement system (see SWP). The two high-PDR scenarios assume PDRs somewhat lower than those estimated with data from the Drawdown (see WP), but are nonetheless at the high end of the range of plausible PDRs that personnel might apply to career retention decisions. The two intermediate cases approximate the mean or median rates that RAND researchers used in their retention work for the Military Compensation and Retirement Modernization Commission (MCRMC).[78]

4. Model Fits under the Current Compensation System

Historical Basis for Model Fits. As discussed above, the officer and enlisted models were calibrated under the low-PDR scenario so that the model predicts actual (historical) survival patterns as closely as possible. But of course there are a number of possible past survival patterns to which the model might be calibrated. To calibrate the enlisted model, we constructed a survival pattern based on the average of FY 2000–2009 all-DoD enlisted continuation rates by YOS.[79] The all-DoD enlisted survival curve fit to these data implies that 13.6 percent of enlisted entrants will remain in service to retirement eligibility at YOS 20. This number is slightly lower than the 15.2 percent rate constructed from data used by the DoD Actuary in its valuation of the military retirement system.[80]

To calibrate the officer model, we constructed a survival pattern based on the average of FY 2008–2009 all-DoD continuation rates for commissioned officers constructed from DMDC Master File extracts available at IDA. We could have used the average of FY 2001–2009 all-DoD continuation rates constructed from the IDA extracts, but the survival to YOS 20 implied by these data (28.7 percent) was somewhat lower than survival to YOS 20 based on the average of 2008–2009 continuation rates (33.4 percent), and the latter rate was more consistent with survival to YOS 20 based on data used by the DoD Actuary in its valuations of the military retirement system (35.9 percent).

The calibrations assume that all entrants are under the High-3 military retirement system now in effect for most military personnel.[81]

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78 In this work, RAND assumed a 12.7 percent discount rate for enlisted personnel and 6.4 percent for officers. These are averages of Service-specific rates that RAND researchers have obtained from estimation of the DRM. See footnotes 100 and 101 of MCRMC, *Report of the Military Compensation and Retirement Modernization Commission: Final Report*.

79 Specifically, we used annual all-DoD continuation rates for enlisted personnel downloaded from DMDC's Interactive Data System (IDS) to construct the cumulative survival rates. We could have used survival rates constructed from FY 2001–2009 DMDC Master File extracts available at IDA. The survival rate to YOS 20 based on these data was only 10.5 percent, somewhat lower than the rate based on either DMDC's IDS data or calculations based on DoD Actuary data. We therefore chose to base our enlisted calibration on the IDS data.

80 Specifically, the 15.2 percent survival rate was constructed from pre-YOS 20 enlisted withdrawal rates found on page 113 of the Actuary's 2013 valuation report (Department of Defense, *Valuation of the Military Retirement System* (Washington, DC: Office of the Actuary, September 30, 2013), http://actuary.defense.gov/Portals/15/Documents/MRF%20ValRpt%202013.pdf) and the post-YOS 19 retirement rates also found on page 113. Note that these survival rates ignore prior service gains.

81 After FY 2001 repeal of the REDUX retirement system that had been in effect for new entrants after August 30, 1986, some members chose to take a $30,000 bonus at YOS 15 and remain under REDUX

Model Fits to Historical Survival Patterns. Table G-2 (on page G-11) shows the average annual historical continuation rates in various YOS intervals for DoD enlisted personnel and officers, respectively.[82] For each group, the table then shows the average annual continuation rate in that interval based on DRM simulations that assume the current compensation system. Based on the continuation rates used to construct Table G-2, Table G-3 shows the fraction of entrants that is expected to survive to various career points in five-year increments.

Since the enlisted and officer models were calibrated assuming the low-PDR scenarios, the predicted continuation rates and survival rates under the low-PDR scenarios tend to be closer to the historical rates than the continuation and rates implied by the other two scenarios. Nevertheless, in all three PDR scenarios, the simulated continuation rates follow the historical rates reasonably closely. It should be noted, however, that the enlisted models tend to over-predict continuation in the YOS 24–26 interval while the officer models under-predict officer continuation after YOS 20.

Based on historical continuation rates and those predicted by the model for the three PDR scenarios, Table G-3 shows the fraction of an entry cohort that is predicted to remain in service at various career points under the current compensation system. Generally speaking, the models closely predict survival to two key career points—YOS 10 and YOS 20. In the enlisted case, all three scenarios over-predict survival to YOS 5. We suspect that this is a result of differences between the term lengths assumed in the enlisted model and actual term lengths. As expected from the discussion of post-YOS 20 continuation, the enlisted model over-predicts somewhat survival to YOS 25 and YOS 30, while the officer model under-predicts survival to those career points. Nevertheless, the models do predict the observed pattern reasonably well.

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rather than revert back to the High-3 system. An early analysis by Asch and Warner, *A Policy Analysis of Alternative Military Retirement Systems*, predicted a minor drop in retention under REDUX.

[82] A continuation rate is the percentage of personnel who begin a year in a given YOS who are still in service at the end of the year.

Table G-3. Historical Survival to Various Career Points Compared to Model Fits

Survival to YOS:	Enlisted				Officer			
	Historical	Low PDR	Intermed PDR	High PDR	Historical	Low PDR	Intermed PDR	High PDR
5	47.4	52.8	54.5	55.5	82.0	82.1	82.3	82.5
10	21.3	22.0	24.0	25.0	51.0	52.2	50.5	49.7
15	14.8	14.9	15.6	15.7	38.9	40.3	37.4	35.6
20	13.6	12.9	13.2	13.0	33.4	34.2	31.1	29.1
25	2.0	3.0	3.0	2.8	14.5	11.4	8.2	6.5
30	0.5	0.9	0.9	0.8	4.9	3.2	2.1	1.5

5. Sensitivity Tests

Aside from whether the DRM accurately predicts observed retention patterns under the current compensation system, one of the key tests of the DRM is whether the predictions it makes about how retention and survival patterns will change following meaningful changes to the compensation are plausible and consistent with available empirical evidence about how retention responds to compensation changes. To conduct such sensitivity tests, we simulated the model for a 10 percent across-the-board increase in BP and a 20 percent across-the-board reduction in military retirement annuities under the current High-3 system. The retirement pay reduction simulated thus shows the estimated effects of the annuity reductions in the BRS.

For each of the three PDR scenarios, Table G-4 shows predicted voluntary retention (ETS retention) rates in various YOS intervals under the current compensation system and predicted rates with the two pay changes described above. As expected, retention increases in the case of the BP increase, and it falls in the case of the 20 percent reduction in retirement annuities. There are several interesting patterns in the table. The first is that the effects of compensation changes on retention are dampened as we move from the low-PDR scenarios to the higher ones. This makes sense, because the more highly individuals discount future dollars, the less they will respond to compensation changes at future career points. The second is that changes in retired pay have a larger relative impact, the closer personnel are to retirement vesting. This is not surprising, because the closer personnel are to retirement vesting, the more a change in retired pay affects lifetime income relative to a change in Active Duty pay. Third, changes in retired pay have a larger predicted impact on officer retention than on enlisted retention. The reason for this was alluded to earlier. Because officers have a higher probability of remaining in service for a 20-year career (and beyond), the DRM predicts that officers will place higher weights on the compensation associated with longer careers. The greater sensitivity of predicted officer retention to retired pay changes results from “probability of receipt” discounting as well as pure time discounting.

Table G-4. Effects of Pay Changes on Retention in Current Compensation System

YOS Interval	Enlisted Personnel: Current System	Enlisted Personnel: 10% BP Increase	Enlisted Personnel: 20% Ret Pay Cut	Officers: Current System	Officers: 10% BP Increase	Officers: 20% Ret Pay Cut
Low-PDR Scenarios						
3–6	43.8	47.7	42.5	74.0	82.2	67.9
7–10	63.5	69.1	60.7	86.3	90.8	81.1
11–14	81.6	85.2	78.5	93.3	94.6	91.1
15–18	90.1	92.2	87.8	96.5	96.7	95.8
20–23	65.0	65.9	67.1	79.0	83.2	78.8
24–27	90.3	91.1	90.0	81.1	83.2	81.5
28–29	69.6	70.3	70.7	75.0	73.9	76.3
Intermediate-PDR Scenarios						
3–6	47.2	50.6	46.3	73.8	80.6	70.3
7–10	64.0	68.9	62.1	83.7	88.3	80.5
11–14	79.0	82.5	76.5	90.8	92.7	89.0
15–18	87.7	90.0	85.9	95.1	95.9	94.1
20–23	65.7	66.2	67.8	74.7	78.8	76.1
24–27	88.7	89.5	88.8	78.8	80.6	79.4
28–29	69.5	69.8	70.2	73.7	72.6	73.4
High-PDR Scenarios						
3–6	49.0	52.2	48.4	73.9	79.7	71.8
7–10	63.8	67.9	62.6	82.3	86.4	80.1
11–14	76.6	80.4	74.9	88.8	91.2	87.2
15–18	86.2	87.9	84.7	93.7	94.8	92.6
20–23	65.7	66.4	67.9	71.9	76.1	74.3
24–27	87.8	88.3	87.6	77.1	79.0	78.9
28–29	69.7	69.5	70.4	72.9	71.6	72.9

Note: No personnel are assumed to make voluntary separation decisions in YOS 19.

How plausible are the retention changes predicted by the model for these compensation changes? Of course, we have no direct empirical evidence about the retention effects of changes in retired pay. But there have been many studies of the retention effects of Active Duty pay changes, most of which have been summarized in Warner and

Asch and Asch, Hosek, and Warner.[83] These studies summarize retention effects of pay changes in the form of an *elasticity*, defined as the percentage change in retention divided by the percentage change in compensation. For example, under the low-PDR scenario for enlisted personnel, the 10 percent across-the-board BP hike is predicted to increase Zone A (YOS 3–6) retention from 43.8 percent to 47.7 percent, a percentage increase of 9 percent. Given that enlisted BP averages about 60 percent of all-cash RMC, a 9 percent voluntary retention increase implies a first-term compensation elasticity of 1.8. This number is well within the range of estimates from econometric studies of retention.[84] The Zone B (YOS 7–10) elasticity for enlisted personnel is also about 1.8. Beyond that zone (YOS interval), retention effects and elasticities diminish sharply. This is due to the fact that voluntary retention is so high to begin with that compensation increases have less room to induce personnel on the margin of a stay-leave decision to stay.

Table G-5 shows the consequences of these compensation changes for survival to various career points.

[83] Warner and Asch, "The economics of military manpower;" and Asch, Hosek, and Warner, "The new economics of manpower."

[84] See the discussion of post-1995 retention studies by Asch, Hosek, and Warner (1094–6) and a summary table of pre-1995 studies (Table 5) found in Warner and Asch.

Table G-5. Effects of Pay Changes on Survival in the Current Compensation System

Survival to YOS:	Enlisted Personnel: No Pay Change	Enlisted Personnel: 10% BP Increase	Enlisted Personnel: 20% Ret Pay Cut	Officers: No Pay Change	Officers: 10% BP Increase	Officers: 20% Ret Pay Cut
Low-PDR Scenarios						
5	52.8	54.2	52.3	82.1	84.8	80.3
10	22.0	25.5	20.6	52.2	61.5	44.7
15	14.9	18.4	13.2	40.3	48.8	33.1
20	12.9	16.4	11.2	34.2	41.6	27.9
25	3.0	4.0	2.8	11.4	17.3	9.3
30	0.9	1.3	0.9	3.2	5.1	2.8
Intermediate-PDR Scenarios						
5	54.5	55.8	54.3	82.3	84.5	81.3
10	24.0	27.1	23.0	50.5	58.5	46.2
15	15.6	18.8	14.4	37.4	44.9	33.0
20	13.2	16.3	11.9	31.1	37.8	27.1
25	3.0	3.7	2.8	8.2	12.4	7.7
30	0.9	1.2	0.9	2.1	3.2	2.0
High-PDR Scenarios						
5	55.5	56.8	55.3	82.5	84.3	81.9
10	25.0	27.8	24.3	49.7	56.6	46.9
15	15.7	18.6	14.8	35.6	42.2	32.6
20	13.0	15.8	12.1	29.1	35.0	26.1
25	2.8	3.5	2.8	6.5	9.8	6.7
30	0.8	1.1	0.9	1.5	2.4	1.7

6. Retention and Survival under the BRS

We consider the retention effects of the BRS in two steps. The first step is to predict retention in the absence of the option to take part of the second-career annuity as a lump sum payment. In the second step, we estimate how the lump sum option changes retention compared with the no lump sum case.

Prior to discussion, it is useful to note that the retention effects of the BRS are analytically ambiguous. The BRS cuts military retirement annuities by 20 percent across the board. As the simulations in the previous section indicated, this 20 percent reduction would, by itself, reduce retention and survival to the 20-year mark. But at the same time that retirement annuities were reduced, all personnel entering under the BRS will be eligible for DoD contributions into FTSP and will receive additional matching contributions from DoD up to 5 percent of BP. Individuals will be fully vested in DoD contributions after two YOS. Depending on how individuals value FTSP contributions and accumulations, those contributions and accumulations will offset some, if not all, of the decline in retention that will result from the reduction in retirement annuities.

To value FTSP accumulations, we assume that individuals will not be able to access fund accumulations prior to age 60, the first age individuals can access their fund balances without tax penalties. For the purpose of determining how individuals value the FTSP, we grow all contributions from the individual's age at contribution to age 60 at the assumed 5 percent rate of return to FTSP, and then discount them back to the age and YOS at the individual's own PDR. Low-PDR individuals will thus value FTSP accumulations more than high-PDR individuals.

BRS without the Lump Sum Option. For each of the three PDR scenarios, Table G-6 shows predicted voluntary retention (retention at ETS) in various YOS intervals under the BRS without the lump sum option. Table G-7 shows predicted survival to various career points. Because the enlisted and officer models were calibrated assuming the low-PDR scenarios, and other model parameters do not change from one scenario to another, predicted current system retention and survival rates are not exactly the same from one scenario to another. What is relevant is how retention and survival are predicted to change within each scenario. The BRS is predicted to have little, if any, effect on initial retention decisions in YOS 3–6. Retention is predicted to decline somewhat in the mid-career YOS intervals. However, the predicted decreases are smaller than those shown in Table G-6 for the cases of the 20 percent reduction in retirement annuities. This indicates that the availability of government contributions to FTSP and continuation pay at YOS 12 restore much of the reduction in retention incentives due to the 20 percent reduction in retirement annuities in the BRS.[85]

It is useful to note that retention in the YOS 20–23 interval is actually predicted to increase under the BRS without the lump sum option. This is due to the sorting on tastes discussed earlier. Because some individuals who would have stayed to the 20-year point under the current system leave prior to that point under the BRS without the lump sum option, the cohort members surviving to the 20-year point have higher average taste for service and are therefore more likely to stay at that point.

Table G-7 shows that, depending on PDR scenario, enlisted retention under the BRS without the lump sum option is predicted to reduce survival to the 20-year mark by between 0.5 percentage points (high-PDR scenario) and 0.9 percentage points (low-PDR scenario). The decline in officer survival is about 1.1–1.2 percentage points in all three scenarios.

85 It is important to note that these simulations assume the smallest allowable amount of continuation pay at YOS 12 (2 months). The BRS gives the Services authority to increase continuation pay up to a maximum of 13 months.

Table G-6. Retention Effects of the BRS without the Lump Sum (LS) Option

YOS Interval	Low-PDR Scenario: Currrent System	Low-PDR Scenario: BRS w/o LS Option	Intermediate-PDR Scenario: Currrent System	Intermediate-PDR Scenario: BRS w/o LS Option	High-PDR Scenario: Currrent System	High-PDR Scenario: BRS w/o LS Option
Enlisted Personnel						
3–6	43.8	43.8	47.2	47.1	49.0	49.0
7–10	63.5	62.0	64.0	63.2	63.8	63.3
11–14	81.6	79.5	79.0	77.4	76.6	75.4
15–18	90.1	87.8	87.7	86.0	86.2	84.7
20–23	65.0	66.1	65.7	67.1	65.7	67.5
24–27	90.3	89.8	88.7	88.5	87.8	87.5
28–29	69.6	69.8	69.5	69.8	69.7	70.1
Officers						
3–6	74.0	74.0	73.8	73.5	73.9	73.7
7–10	86.3	85.1	83.7	82.9	82.3	81.6
11–14	93.3	92.3	90.8	90.1	88.8	88.1
15–18	96.5	96.0	95.1	94.4	93.7	92.8
20–23	79.0	80.7	74.7	77.4	71.9	75.4
24–27	81.1	82.6	78.8	80.4	77.1	79.6
28–29	75.0	75.2	73.7	73.7	72.9	73.0

No personnel are assumed to make voluntary separation decisions in YOS 19.

Table G-7. Effects of the BRS without the Lump Sum Option on Survival

Survival to YOS:	Low-PDR Scenario		Intermediate-PDR Scenario		High-PDR Scenario	
	Current System	BRS w/o LS Option	Current System	BRS w/o LS Option	Current System	BRS w/o LS Option
Enlisted Personnel						
5	52.8	52.8	54.5	54.5	55.5	55.5
10	22.0	21.6	24.0	23.7	25.0	24.8
15	14.9	14.2	15.6	15.0	15.7	15.3
20	12.9	12.0	13.2	12.5	13.0	12.5
25	3.0	2.8	3.0	2.9	2.8	2.8
30	0.9	0.9	0.9	0.9	0.8	0.9
Officers						
5	82.1	82.2	82.3	82.3	82.5	82.5
10	52.2	51.4	50.5	49.8	49.7	49.1
15	40.3	39.0	37.4	36.4	35.6	34.7
20	34.2	32.9	31.1	29.9	29.1	27.9
25	11.4	12.1	8.2	9.2	6.5	7.6
30	3.2	3.7	2.1	2.4	1.5	1.9

BRS with the Lump sum Option. This section considers the effects of the lump sum option in the BRS on retention and survival. As discussed in Chapter 1, the BRS offers Active Duty personnel who complete 20 YOS the option to take either 25 percent or 50 percent of the annuity that they would receive from the age at separation to age 67 in the form of a lump sum payment. This section discusses results of simulations of the retention effects of the lump sum option. The lump sum option is simulated based on three (real) Government Discount Rates (GDRs) used to construct the lump sum amounts—2.5 percent, 5 percent, and 7.5 percent. In the absence of other considerations, who will be motivated to stay or leave due to the availability of the lump sum payments is easily described. If an individual has a PDR that exceeds the GDR, that individual will place a lower present value on the future annuity payments they would have received without the lump sum option than they will receive by exercising the lump sum option. Such a person will exercise the lump sum option upon separation. Such a person will be more likely to remain in service to the 20-year mark, but also less likely to stay after retirement vesting to the extent that the lump sum option raises the value of leaving relative to the value of staying. Personnel with PDRs below the GDR will be unaffected by the lump sum option; their retention and survival will be the same as it would have been without the lump sum option. For any given GDR, the fraction of personnel at risk to change their retention decisions increases as we move from the low-PDR scenarios to the higher scenarios. Therefore, we expect larger deviations from the retention and survival patterns predicted above for the no lump sum option as we move from the low-PDR scenarios to the higher scenarios.

However, we found in our analysis of lump sum take rates in the FY 2015 new retiree cohort that there are two additional factors that are likely to significantly affect (reduce) the likelihood of exercising the lump sum option. If personnel are fully informed about these factors prior to reaching retirement eligibility, they will serve to dampen the differences in retention and survival, both before and after the 20-year mark.

The first factor arises from differences in tax treatment of lump sum payments and annuities. Due to the graduation of tax rates in the federal income tax system, the lump sum payments in the BRS will be taxed at higher marginal rates than annuity payments will be. Our take rate analysis estimated that new retirees in FY 2015 would have lump sum payments taxed at an average rate of 26 percent and annuity payments taxed at an average rate of 15 percent. Differences in tax treatment serve to raise the discount rate that equates the present value of after-tax annuity payments with the after-tax lump sum. We call this rate the breakeven rate (BER). How much BER increases depends on the GDR. We calculated that if the GDR is 2.5 percent, the average BER among the new Active Duty retirees in the FY 2015 is about 4 percent (a 60 percent increase). The percentage increases in BER above GDR are somewhat smaller as GDR increases, because the lump sum payments—and thus tax differences—are smaller. To account for tax effects, we set BER = d*GDR, where d is the multiplier arising from differences in tax treatment (e.g., 1.6 in the case of GDR = 2.5 percent). Individuals are thus assumed to exercise the lump sum option of PDR > BER. Again, if personnel are fully informed about differences in tax treatment prior to reaching retirement eligibility, this difference will reduce the retention and survival effects of the lump sum option.

The second factor amplifies the effects of the difference in tax treatment. Military retirees who apply for Department of Veterans Affairs (VA) disability compensation and receive a VA disability rating of less than 50 percent will be subject to VA benefit offsets. After receiving a disability rating, these retirees will not receive any VA disability benefits until they have "paid back" the lump sum payment received at separation. Over the waiting period before the lump sum is paid back, the retiree loses the tax advantage that they would have received had they not taken the lump sum payment.[86] Our calculations with the FY 2015 retiree cohort indicated that the lost tax advantage on VA disability payments

[86] If the retiree had not taken the lump sum and had qualified for VA disability compensation payments with a rating of less than 50 percent, the retiree's military retired pay would be reduced dollar-for-dollar with the VA disability benefits they receive. But even though the retiree's gross income does not change as a result of the offset to annuity income, the retiree would gain after-tax income due to the fact that military retirement payments are taxable and VA disability payments are not. Retirees who take the lump sum forgo this tax advantage over the waiting period required to have the lump sum payment offset (paid back).

raises BER relative to what it would otherwise be.[87] We assume that 30 percent of retirees will become eligible for VA disability payments at ratings of less than 50 percent.[88]

Simulations were first run assuming that personnel ignore both VA offsets and the tax consequences of exercising the lump sum option and then that they are aware of these factors. Table G-8 and Table G-9 show predicted retention under the BRS without the lump sum option and then deviations from those rates due to the availability of the lump sum option. Table G-8 is based on the assumption of no awareness of VA offsets and differences in tax treatment of lump sums and annuities and VA offsets, while Table G-9 assumes awareness.

Inspecting Table G-8, the availability of the lump sum option is predicted to increase retention prior to retirement eligibility at YOS 20. The predicted increases are minor at the initial retention decision point, but grow in size as personnel get closer to YOS 20. However, even by the YOS 15–18 interval, the increases are relatively small. Looking first at the case in which lump sums are constructed using a 2.5 percent GDR, the enlisted retention improvements in the YOS 15–18 interval range from 2 percent (low-PDR scenario) to 2.5 percent (high-PDR scenario), and the officer improvements range from 0.3 perecent (low-PDR scenario) to 1.4 percent (high-PDR scenario). As expected, the improvements in retention prior to the 20-year mark decline as the GDR increases and lump sum amounts decline.

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87 Our calculations indicate that retirees subject to VA offsets have an average BER of approximately 5.5 percent when GDR = 2.5 percent.

88 The 30 percent figure was based on veterans in the 2011–2015 ACSs. Approximately, 30 percent of veterans in the ACSs can be identified as recent military retirees (retirees between age 35 and 59 who were on Active Duty after 2000 and have VA disability ratings between 10 percent and 40 percent).

Table G-8. BRS Retention without the Lump Sum Option and Changes Due to the Option at GDRs of 2.5%, 5%, and 7.5% (Unaware of Tax Effects and VA Offsets)

	Low-PDR Scenario				Intermediate-PDR Scenario				High-PDR Scenario			
YOS Int	No LS	2.5% GDR	5% GDR	7.5% GDR	No LS	2.5% GDR	5% GDR	7.5% GDR	No LS	2.5% GDR	5% GDR	7.5% GDR
Enlisted Personnel												
3–6	43.8	0.5	0.1	0.0	47.1	0.4	0.2	0.0	49.0	0.4	0.1	0.0
7–10	62.0	1.4	0.6	0.2	63.2	1.4	0.6	0.2	63.3	1.0	0.5	0.2
11–14	79.5	1.5	0.7	0.3	77.4	1.9	1.0	0.6	75.4	2.0	1.1	0.5
15–18	87.8	2.0	1.2	0.6	86.0	2.5	1.4	0.8	84.7	2.5	1.3	0.7
20–23	66.1	-4.9	-2.7	-1.3	67.1	-6.8	-4.1	-2.4	67.5	-9.1	-5.5	-3.4
24–27	89.8	0.3	0.3	0.2	88.5	-0.1	0.2	0.1	87.5	-0.1	0.1	0.2
28–29	69.8	-0.7	-0.5	-0.2	69.8	-1.1	-0.6	-0.5	70.1	-1.7	-1.5	-0.8
Officers												
3–6	74.0	0.5	0.1	0.0	73.5	0.8	0.3	0.1	73.7	0.8	0.3	0.1
7–10	85.1	0.5	0.1	0.0	82.9	0.9	0.3	0.1	81.6	1.1	0.4	0.2
11–14	92.3	0.4	0.1	0.0	90.1	0.8	0.4	0.2	88.1	1.3	0.6	0.3
15–18	96.0	0.3	0.1	0.1	94.4	0.9	0.5	0.2	92.8	1.4	0.8	0.4
20–23	80.7	-2.1	-0.7	-0.3	77.4	-6.3	-3.0	-1.5	75.4	-10.2	-5.7	-3.2
24–27	82.6	-0.3	-0.2	-0.1	80.4	-0.9	-0.4	0.0	79.6	-1.8	-1.3	-0.8
28–29	75.2	0.2	0.2	0.2	73.7	0.2	-0.3	0.1	73.0	0.9	0.1	-0.3

Note: No personnel are assumed to make voluntary separation decisions in YOS 19.

The estimates in Table G-8 point to a decline in retention after personnel become retirement-eligible, with the declines increasing as the GDR is decreased and lump sum amounts increase. Not surprisingly, the retention declines increase in size as PDRs increase. Some of the post-YOS 20 decline represents a pure incentive effect arising from the fact that, for a given individual, the availability of the lump sum option raises the payoff to leaving relative to the payoff from longer service. The other part of the decline arises from the fact that the availability of the lump sum option has pulled to the 20-year point some personnel who would have departed earlier without the availability of the lump sum option.

Under the assumption that personnel account for tax effects and VA offsets in their retention decisions, the retention effects of the lump sum option, both positive prior to retirement vesting and negative after retirement vesting, become more muted (Table G-9). The true retention effects of the lump sum option are likely to lie somewhere in between these extremes. On the one hand, the estimates in Table G-9 require that personnel be fully informed about differences in tax treatment of lump sums and annuities well before the date of retirement and, furthermore, that they might be eligible for VA disability compensation—and thus subject to VA offsets to lump sum payments—after retirement. On the other hand, as part of the legislation establishing the BRS, NDAA 2016 instructed DoD to establish a financial education program for military personnel. DoD is already in the process of developing such a program, and it will include education related to income taxation and VA disability compensation. So it is unrealistic to assume that personnel will be completely oblivious to tax effects and VA offsets.

Table G-9. BRS Retention without the Lump Sum Option and Changes Due to the Option at GDRs of 2.5%, 5%, and 7.5% (Aware of Tax Effects and VA Offsets)

	Low-PDR Scenario				Intermediate-PDR Scenario				High-PDR Scenario			
YOS Int	No LS	2.5% GDR	5% GDR	7.5% GDR	No LS	2.5% GDR	5% GDR	7.5% GDR	No LS	2.5% GDR	5% GDR	7.5% GDR
Enlisted Personnel												
3–6	43.8	0.2	0.1	0.0	47.1	0.2	0.1	0.0	49.0	0.2	0.1	0.0
7–10	62.0	0.7	0.3	0.1	63.2	0.7	0.3	0.2	63.3	0.6	0.2	0.1
11–14	79.5	0.8	0.4	0.1	77.4	1.2	0.7	0.3	75.4	1.2	0.7	0.2
15–18	87.8	1.3	0.7	0.4	86.0	1.6	1.0	0.6	84.7	1.6	0.8	0.4
20–23	66.1	-3.2	-1.7	-0.8	67.1	-4.7	-2.9	-1.6	67.5	-6.3	-3.8	-2.4
24–27	89.8	0.2	0.2	0.1	88.5	0.2	0.0	0.0	87.5	0.2	0.1	0.3
28–29	69.8	-0.6	-0.2	-0.3	69.8	-0.7	-0.2	-0.5	70.1	-1.6	-0.9	0.0
Officers												
3–6	74.0	0.2	0.1	0.0	73.5	0.4	0.1	0.0	73.7	2.6	0.2	0.1
7–10	85.1	0.2	0.0	0.0	82.9	0.4	0.2	0.0	81.6	2.4	0.3	0.1
11–14	92.3	0.2	0.1	0.0	90.1	0.5	0.2	0.1	88.1	2.2	0.4	0.1
15–18	96.0	0.1	0.1	0.0	94.4	0.6	0.3	0.1	92.8	0.9	0.5	0.3
20–23	80.7	-1.0	-0.4	-0.2	77.4	-3.6	-2.0	-0.9	75.4	-6.6	-3.9	-2.1
24–27	82.6	-0.1	-0.1	0.0	80.4	-0.6	-0.1	0.0	79.6	-1.3	-0.9	-0.5
28–29	75.2	0.2	0.2	0.1	73.7	-0.1	0.2	0.1	73.0	0.1	0.0	-0.3

Table G-10 and Table G-11 show the predicted probabilities of survival to various career points under the BRS without the lump sum option and changes in survival rates under the different PDR scenarios and GDRs, the first table assuming personnel are not aware of tax effects and VA offsets and the second table assuming that they are. The same patterns are evident in these tables as were evident in the previous two tables. The positive pull effect of the lump sum option increases the closer personnel are to the 20-year mark. The effects are larger the lower the GDR and for the scenarios involving higher PDRs. The lump sum option reduces survival (pushes personnel out) after the 20-year mark. Again, push effects are most pronounced in the high-PDR scenarios and for the case in which a 2.5 percent discount rate is used to construct the lump sum payments.

Table G-10. BRS Survival without the Lump Sum Option and Changes Due to the Option at GDRs of 2.5%, 5%, and 7.5% (Unaware of Tax Effects and VA Offsets)

	Low-PDR Scenario				Intermediate-PDR Scenario				High-PDR Scenario			
YOS	No LS	2.5% GDR	5% GDR	7.5% GDR	No LS	2.5% GDR	5% GDR	7.5% GDR	No LS	2.5% GDR	5% GDR	7.5% GDR
Enlisted Personnel												
5	52.8	0.2	0.1	0.0	54.5	0.1	0.1	0.0	55.5	0.1	0.0	0.0
10	21.6	0.5	0.2	0.1	23.7	0.5	0.2	0.1	24.8	0.5	0.2	0.1
15	14.2	0.7	0.3	0.1	15.0	0.8	0.4	0.2	15.3	0.8	0.4	0.2
20	12.0	0.9	0.4	0.2	12.5	1.1	0.5	0.3	12.5	1.0	0.5	0.2
25	2.8	-0.2	-0.1	-0.1	2.9	-0.4	-0.3	-0.2	2.8	-0.7	-0.4	-0.3
30	0.9	-0.1	-0.1	0.0	0.9	-0.2	-0.1	-0.1	0.9	-0.3	-0.2	-0.1
Officers												
5	82.2	0.1	0.0	0.0	82.3	0.2	0.1	0.0	82.5	0.2	0.1	0.0
10	51.4	0.6	0.2	0.1	49.8	1.2	0.4	0.1	49.1	1.2	0.5	0.2
15	39.0	0.8	0.2	0.1	36.4	1.3	0.5	0.2	34.7	1.7	0.8	0.3
20	32.9	0.8	0.3	0.1	29.9	1.5	0.6	0.3	27.9	2.0	1.0	0.4
25	12.1	-0.8	-0.3	-0.1	9.2	-2.0	-1.0	-0.5	7.6	-2.6	-1.6	-1.0
30	3.7	-0.3	-0.1	0.0	2.4	-0.5	-0.3	-0.1	1.9	-0.7	-0.5	-0.3

Comparison of Table G-10 and Table G-11 indicates that the pull and push effects of the lump sum option will be quite muted if personnel fully account for tax effects and VA offsets in their retention decisions.

Table G-11. BRS Survival without the Lump Sum Option and Changes due to the Option at GDRs of 2.5%, 5%, and 7.5% (Aware of Tax Effects and VA Offsets)

	Low-PDR Scenario				Intermediate-PDR Scenario				High-PDR Scenario			
YOS	No LS	2.5% GDR	5% GDR	7.5% GDR	No LS	2.5% GDR	5% GDR	7.5% GDR	No LS	2.5% GDR	5% GDR	7.5% GDR
Enlisted Personnel												
5	52.8	0.1	0.0	0.0	54.5	0.1	0.0	0.0	55.5	0.1	0.0	0.0
10	21.6	0.3	0.1	0.0	23.7	0.2	0.1	0.0	24.8	0.2	0.1	0.0
15	14.2	0.4	0.2	0.1	15.0	0.4	0.2	0.1	15.3	0.4	0.2	0.1
20	12.0	0.5	0.2	0.1	12.5	0.6	0.3	0.2	12.5	0.6	0.3	0.1
25	2.8	-0.2	-0.1	0.0	2.9	-0.3	-0.2	-0.1	2.8	-0.5	-0.3	-0.2
30	0.9	-0.1	0.0	0.0	0.9	-0.1	-0.1	-0.1	0.9	-0.2	-0.1	-0.1
Officers												
5	82.2	0.1	0.0	0.0	82.3	0.1	0.0	0.0	82.5	0.1	0.0	0.0
10	51.4	0.3	0.1	0.0	49.8	0.5	0.2	0.0	49.1	0.6	0.3	0.1
15	39.0	0.3	0.1	0.0	36.4	0.7	0.3	0.1	34.7	0.9	0.5	0.1
20	32.9	0.3	0.1	0.0	29.9	0.8	0.4	0.1	27.9	1.1	0.6	0.2
25	12.1	-0.4	-0.2	-0.1	9.2	-1.2	-0.7	-0.3	7.6	-1.8	-1.2	-0.6
30	3.7	-0.1	-0.1	0.0	2.4	-0.3	-0.2	-0.1	1.9	-0.5	-0.3	-0.2

A Summary Statistic for the Analyses: Person-Years per Accession. A useful statistic that summarizes retention and survival under a given compensation regime is person-years per accession (PYPA). This statistic simply indicates how many years an entrant is expected to remain in service under that regime. Based on the historical data used for the model calibrations, PYPA is 6.58 for enlisted personnel and 11.84 for officers (shown in Table G-12). As noted earlier, the enlisted and officer models were calibrated for the low-PDR scenarios, so we would expect that that the model PYPAs under the current compensation system would be closest to historical PYPAs for the low-PDR scenarios. And they are. Under the low-PDR scenarios, the enlisted model PYPA differs from the historical PYPA by only 0.15 years and the officer model PYPA differs from the historical PYPA by 0.2 years. The deviations between model PYPA and historical PYPA are somewhat larger for the other two PDR scenarios, but that is because other model parameters were not varied along with the median PDRs.[89]

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[89] Readers will no doubt wonder why enlisted PYPA increases as we move across PDR scenarios while officer PYPA decreases. The explanation has to do with the fact that the DRM accounts, on an individual basis, for the perceived probabilities of following different career paths. Officers have three times the mean probability of staying for a career of 20 years or more as enlisted personnel and therefore place a much higher weight on far-term pays. The result is that, if PDRs go up, they discount those pays at a higher rate and staying in is not as attractive; therefore, their retention declines. One might think that the same thing would happen in the enlisted case, but because enlisted personnel have a

Looking at the effects of the BRS on PYPA by PDR scenario, the first thing to notice is that PYPA under the BRS without the lump sum option is only marginally smaller than PYPA under the current compensation system. The differences are 0.15 person-years or less in all cases.

The second thing to notice is that the lump sum option also has minor effects on PYPA. While the difference between PYPA with and without the lump sum option grows as the discount rate that DoD uses to construct the lump sum payments decreases, the differences are never larger than 0.1 person-years. If DoD were to use a 7.5 percent discount rate to construct the lump sum payments, PYPA barely changes from what it would have been without the lump sum option. Furthermore, these conclusions hold whether or not personnel are assumed to be aware of potential VA offsets to lump sum payments or of differences in tax treatment of lump sum payments and annuities.

Finally, it is useful to contrast the effects of the BRS with or without the lump sum option on person-years with compensation changes that do "move the needle." The models predict that a 10 percent across-the-board increase in BP that is expected to be permanent will increase PYPA by at least 0.5 person-years, and perhaps by more than 1 person-year, depending on PDR scenario.

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low probability of staying for a 20-year career to begin with, they are placing a lot more weight on near-term pays in their decision-making. In their case, when PDRs go up, they place even higher weights on near-term pays, where the pay spreads between military RMC and civilian wages are quite positive.

Table G-12. Person-Years per Accession

		PYPA Based on Historical Data	Model PYPAs by PDR Scenario: Low	Intermed	High
Enlisted Personnel					
Current Compensation System		6.58	6.73	6.95	7.03
Current + 10% BP Increase			7.36	7.51	7.54
Current + 20% Retirement Pay Cut			6.48	6.79	6.92
BRS without LS Option			6.63	6.89	7.00
BRS with LS Option					
GDR = 2.5%	Unaware		6.71	6.95	7.03
	Aware		6.66	6.91	7.00
GDR = 5%	Unaware		6.66	6.90	7.00
	Aware		6.64	6.89	6.99
GDR = 7.5%	Unaware		6.64	6.89	6.99
	Aware		6.64	6.89	6.98
Officers					
Current Compensation System		11.84	12.04	11.58	11.34
Current + 10% BP Increase			13.55	12.92	12.48
Current + 20% Retirement Pay Cut			10.86	10.91	10.90
BRS without LS Option			11.89	11.48	11.25
BRS with LS Option					
GDR = 2.5%	Unaware		11.96	11.58	11.34
	Aware		11.92	11.48	11.28
GDR = 5%	Unaware		11.91	11.51	11.27
	Aware		11.89	11.48	11.25
GDR = 7.5%	Unaware		11.89	11.48	11.25
	Aware		11.89	11.47	11.24

Appendix H.
Technical Description of the DRM

The Dynamic Retention Model (DRM) allows decision makers to be aware of the fact that a random shock in any future period may induce them to leave. Rather than be guided by the payoff over some dominant future time horizon, decision makers in the DRM are guided by payoffs over all future possible future career paths weighted by the probabilities that individuals will follow those paths. In this model, high-taste (high τ) individuals have higher probabilities of staying in each future period than low-taste (low τ) individuals. Recognizing this, they place larger weights on payoffs involving long military careers and smaller weights on payoffs involving shorter careers compared to the low-taste individuals. High-taste individuals are thus more affected by a pay change at a distant future time period than are low-taste individuals.

Consider, for example, an individual at the end of an initial enlistment considering whether to stay or leave. This individual has a very large number of potential future career paths, especially when promotion is considered. To keep the exposition simple, promotion is ignored for now but is easy to model. To efficiently evaluate payoffs and probabilities of the different paths, the DRM uses the method of backward induction. Let period *T* be the terminal period of service. The individual must leave at the end of period *T*. Let $E(R_T^M)$ denote the expected present value of the future retirement stream the individual expects to receive if they depart after period *T* and $E(W_T^C)$ the expected present value of the future civilian wage stream. The expected value of leaving after terminal year *T* is the sum of these two present values: $E(V_T^C) = E(W_T^C) + E(R_T^M)$.

The expected values of remaining for the terminal period and leaving at the end of period *T-1* are given by

$$\begin{aligned} E(V_T^M) &= \tau + w_T^M + dE(V_T^C) \\ E(V_{T-1}^C) &= E(W_{T-1}^C) + E(R_{T-1}^M) \end{aligned} . \qquad \text{(H-1)}$$

What does the individual do? That depends on random shocks to the expected values. Let ε_{T-1}^M be a random shock to the value of staying for period *T* and ε_{T-1}^C be a random shock to the value of leaving. The choice criterion is to stay if the actual value of staying, $V_{T-1}^M = E(V_{T-1}^M) + \varepsilon_{T-1}^M$, exceeds the actual value of leaving, $V_{T-1}^C = E(V_{T-1}^C) + \varepsilon_{T-1}^C$. The probability of staying at time *T-1* is given by

$$P(V_{T-1}^M > V_{T-1}^C) = P(E(V_{T-1}^M) + \varepsilon_{T-1}^M > E(V_{T-1}^C) + \varepsilon_{T-1}^C) = P(E(V_{T-1}^M) - E(V_{T-1}^C) > \varepsilon_{T-1}^C - \varepsilon_{T-1}^M) . \quad \text{(H-2)}$$

To specify this probability function, one needs to make an assumption about the distribution of the random shocks ε_{T-1}^M and ε_{T-1}^C. Early versions of the DRM assumed them to be normally distributed with mean 0 and standard deviation σ_ϵ. More recent versions have assumed them to follow an extreme value distribution. The cumulative distribution function of the extreme value distribution is given by $F(\varepsilon_t^i) = \exp(-\exp(-\varepsilon_t^i / s))$, where *i* is the choice {M, C} and *s* is a shape parameter, which is related to variance by the formula $\sigma_\varepsilon^2 = s^2\pi^2 / 6$ (such that $s = \sqrt{6}\sigma_\varepsilon / \pi$). Under the assumption of an extreme value distribution for the random shocks, the probability of staying follows a cumulative logit distribution given by equation (H-3).

$$P(V_{T-1}^M > V_{T-1}^C) = \frac{\exp(E(V_{T-1}^M)/s)}{\exp(E(V_{T-1}^M)/s) + \exp(E(V_{T-1}^C)/s)} . \quad \text{(H-3)}$$

The individual's expected utility at the start of period *T* is the maximum of $V_{T-1}^M = E(V_{T-1}^M) + \varepsilon_{T-1}^M$ and $V_{T-1}^C = E(V_{T-1}^C) + \varepsilon_{T-1}^C$. This expected value is given by $E(V_{T-1}^*) = E\left(\max(V_{T-1}^M, V_{T-1}^C)\right)$. Under the assumption that the random shocks follow extreme value distributions,

$$E(V_{T-1}^*) = E\left(\max(V_{T-1}^M, V_{T-1}^C)\right) = s\left[\gamma + \ln(\exp(E(V_{T-1}^M / s) + \exp(E(V_{T-1}^C / s))\right], \quad \text{(H-4)}$$

where the parameter $\gamma \approx 0.5776$ is Euler's constant.[90]

Beginning with the calculated period *T-1* expected values of staying and leaving, the probability of staying, and expected utility, the individual recursively calculates values of these functions for prior periods, as follows:

$$E(V_t^M) = \tau + w_t^M + dE(V_{t+1}^*)$$
$$E(V_t^C) = E(W_t^C) + E(R_t^M) \quad \text{(H-5)}$$

$$P(V_t^M > V_t^C) = \Lambda_t = \frac{\exp(E(V_t^M)/s)}{\exp(E(V_t^M)/s) + \exp(E(V_t^C)/s)} \quad \text{(H-6)}$$

90 The proof that equation (H-6) for probability and equation (H-7) for expected utility follow from the assumption that the random shocks follow an extreme value distribution with parameter *s* was first provided in M. Ben-Akiva and S. Lerman, *Discrete Choice Analysis: Theory and Application to Travel Demand* (Cambridge, MA: MIT Press, 1986), https://mitpress.mit.edu/books/discrete-choice-analysis.

$$E(V_{t+1}^{*}) = E\left(\max(V_{t+1}^{M}, V_{t+1}^{C})\right) = s\left[\gamma + \ln(\exp(E(V_{t+1}^{M} / s) + \exp(E(V_{t+1}^{C} / s))\right] \qquad \text{(H-7)}$$

Future pays affect the value of staying through the term for expected future utility in period *t+1* given by equation (H-7). It may be shown that this term is a weighted average of the values of all possible future stay-leave sequences. The weights are based on the individual's taste-for-service factor as well as on (the distribution of) random shocks which individuals anticipate may induce them to separate at each future decision point. On one hand, individuals with a low taste for military service will anticipate that they are not likely to stay for a long career and will therefore not place a high weight on long-term payoffs compared to the weight they place on short-term payoffs. High-taste individuals, on the other hand, anticipate long careers and therefore place more weight on long-term pays compared to short-term pays.

The probability that an individual with given taste factor τ will stay *t-1* periods and then leave in period *t* is given by $\left(\prod_{k=1}^{t-1} \Lambda_k\right)\Lambda_t$. This is simply the probability that the payoff to staying will exceed the payoff to leaving in each of the first *t-1* periods and then be less in period *t*. Let dF(τ) denote the distribution of tastes in the entry cohort. Then the expected fraction of the entry cohort that will remain in service for exactly *t* periods is given by

$$Q_t = \int_{-\infty}^{\infty} \left(\left[\prod_{k=1}^{t-1} \Lambda_k\right](1-\Lambda_t)\right) dF(\tau)\,. \qquad \text{(H-8)}$$

Q_t is simply a weighted average of the individual probabilities of remaining *t-1* periods and then leaving in period *t*.

Appendix I. Post-Service Earnings Functions and the Simulation of Post-Service Earnings

It is well established in the economics literature that civilian earnings, denoted *Y*, follow a log-normal distribution. Thus, the natural logarithm of civilian earnings (log(*Y*)) is normally distributed and the distribution of *Y* is left-skewed. It is also well established that earnings over an individual's career are well described by a quadratic function in which earnings grow with respect to years of labor market experience, but at a diminishing rate, and may actually decline late in the career cycle. Furthermore, as Goldberg and Warner established,[91] a year of military experience may not contribute as much to civilian earnings as a year of civilian experience. We therefore employ the Goldberg-Warner specification for the logarithm of expected (mean) post-service earnings:

$$E(log(Y)) = b_0 + b_1(t\text{-}m) + b_2(t\text{-}m)^2 + b_3m + b_4m^2 + b_5(t\text{-}m)m.$$

In this equation, *t* represents total years of labor market experience, *m* represents years of military experience, and *t-m* represents years of post-service experience in the civilian sector. The parameter b_0 is the natural log of earnings at labor market entry (sometimes called base earnings). The parameter b_1 shows how post-service earnings initially grow after the individual leaves service and the parameter b_3 shows the linear contribution of a year of military experience to post-service earnings. However, earnings growth tends to diminish as experience accumulates, so the (negative) parameters b_2 and b_4 control how much earnings growth diminishes as years of post-service experience and military experience increase. Finally, the term (*t-m*)*m* allows for an interaction between post-service experience and military experience. Parameters of the post-service earnings function are populated based on the Goldberg-Warner study as well as the many studies of lifecycle earnings available in the economics literature.

Finally, it is well known that there are persistent earnings differences across individuals due to unobservable factors, and that these random factors are approximately normally distributed. Thus post-service earnings opportunities of a given entrant are described by the function

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[91] M. Goldberg and J. Warner, "Military experience, civilian experience and the earnings of Veterans," *Journal of Human Resources* 22, No. 1 (Winter 1987): 61–81, doi: http://www.jstor.org/stable/145867.

$$Log(Y) = b_0 + b_1(t\text{-}m) + b_2(t\text{-}m)^2 + b_3 m + b_4 m^2 + b_5(t\text{-}m)m + \varepsilon_Y ,$$

where ε_Y is a normally distributed random error with mean 0 and standard deviation σ_Y. The parameter σ_Y indicates the degree of individual heterogeneity in civilian earnings. Values of σ_Y are based on the literature.

Appendix J.
Voluntary FTSP Contributions

This appendix discusses the estimates of the percentage of personnel making voluntary contributions to the Federal Thrift Savings Plan (FTSP). Recall that the model predicts that an individual will make voluntary contributions to FTSP if the individual's PDR is less than $m*r$, where r is the market rate of return to the plan and m is a multiplier that accounts for the impact of government matching contributions to the return on a dollar of individual contributions. As discussed in the text, m rises with age, which leads to the prediction that the likelihood that the individual will make voluntary contributions will also increase with age.

Table J-1 shows predicted participation rates in five-year increments of YOS beginning with YOS 5. As expected, predicted voluntary contribution rates do increase with YOS in each PDR scenario. And as also expected, predicted voluntary contribution rates decline across the scenarios. Within each PDR scenario, officers are predicted to make voluntary contributions at a higher rate than enlisted personnel. This outcome is due to the fact that within each scenario, the median officer PDR is lower than the median enlisted PDR. Had the median rates been the same, the predicted voluntary contribution rates would have been the same.

Table J-1. Predicted Percentages of Personnel Making Voluntary Contributions to the Federal Thrift Savings Plan

	LOW PDRs		Intermediate PDRs		High PDRs	
YOS	Enlisted	Officer	Enlisted	Officer	Enlisted	Officer
5	59.0	86.4	39.6	59.0	26.2	39.6
10	61.6	87.9	42.1	61.6	28.6	42.1
15	64.9	89.5	45.4	64.9	31.7	45.4
20	69.7	91.7	50.4	69.7	36.6	50.4
25	76.5	94.4	58.5	76.5	44.6	58.5
30	86.4	97.4	72.2	86.4	59.0	72.2

It is useful to examine the consistency of these predictions with actual FTSP participation. To do so, we utilize the administrative database that DMDC prepared for the

CSB/REDUX study conducted by Simon, Warner, and Pleeter.[92] This database consisted of all Active Duty personnel still on Active Duty as of the end of FY 2008 who completed 15 YOS sometime between the start of FY 2001 and the end of FY 2008—about 193,000 personnel. DMDC assembled a rich set of annual data on these individuals during the FY 2001–2008 period. Military personnel became eligible to participate in FTSP on a non-contributory basis in FY 2002. The database contains an indicator for FTSP enrollment each year over the period as well as the amount of annual individual contributions to FTSP.

Table J-2 provides a summary of FTSP enrollment and contributions as a percentage of annual BP by YOS interval. The table also shows the number of person years observed in each YOS interval. Most observations are in the YOS 11–15 and YOS 16–22 intervals. The database is representative of the mid-career force, but unfortunately contains no information on the junior part of the force. Nevertheless, the database provides insights about voluntary contributions by careerists to FTSP and, furthermore, about the plausibility of the different PDR scenarios.

Table J-2. Percent of Personnel in CSB/REDUX Study Database Enrolled in FTSP by YOS Interval in the Year of Observation, FY 2002–2008

	Enlisted			Officer		
YOS	Person Years	Percent Enrolled	Contribution Rate*	Person Years	Percent Enrolled	Contribution Rate
7–10	72,115	23.8	5.2	34,543	41.9	8.5
11–15	480,129	31.2	6.1	164,110	50.3	8.6
16–22	419,235	35.6	7.0	133,678	54.7	9.4
Total	**971,479**	**32.6**	**6.5**	**332,331**	**51.2**	**9.0**

* The contribution rate is the average contribution as a percent of BP among those enrolled.

The table shows that during FY 2002–2008, over half of officers and about a third of enlisted personnel were making voluntary contributions to FTSP *on a non-matching basis*. Furthermore, those who were participating in FTSP contributed over 5 percent of BP in all YOS intervals. These participation and contribution rates are inconsistent with the voluntary participation percentages predicted above for the high-PDR scenarios. That is because the rates predicted for the mid-career force (e.g., those at YOS 10, 15, and 20) in the high-PDR scenarios are no higher than the actual rates for mid-careerists in the FY 2002–2008 period. Had the government been making matching contributions in that period, it is likely that FTSP participation would have been higher. How much higher is

[92] Curtis J. Simon, John T. Warner, and Saul Pleeter, "Discounting, Cognition, and Financial Awareness: New Evidence from a Change in the Military Retirement System," *Economic Inquiry* 53, No. 1 (January 2015): 318–34, doi: 10.1111/ecin.12146.

uncertain, but they would not have to rise a lot to be consistent with voluntary contribution rates predicted for the intermediate-PDR scenario.

Illustrations

Figures

Figure ES-1. Lump Sum Take Rates as a Function of PDR Distribution and GDR Used in Calculating Lump Sums ... vi
Figure ES-2. Government Savings as a Function of the Real Discount Rate Used in Calculating Lump Sums ... vii
Figure 1. Annuity Interest Rate Index History 2012–2016 (Nominal) ... 14
Figure 2. Effective Nominal Discount Rate by Age under Section 417 Rules ... 15
Figure 3. Trend in State Pension Fund Nominal Growth Rate Assumptions ... 17
Figure 4. Federal Government Cost of Lump-Sum Payout at Two Different Real Discount Rates ... 18
Figure 5. Lump Sum Take Rates as a Function of Real Government Discount Rate ... 23
Figure 6. Government Savings as a Function of Real Government Discount Rate ... 25
Figure 7. Characteristics of Discount Rate Choices ... 27
Figure 8. Implications of Possible Benchmark Discount Rates ... 28
Figure A-1. Histograms, Breakeven Discount Rate (top), and Expected PDR (bottom) ... A-16
Figure B-1. Base Case PDR Scenarios ... B-9
Figure G-1. PDR Distributions for the Three Scenarios ... G-12

Tables

Table ES-1. Change in Percent of a Cohort Remaining in Service through 25 Years of Service ... vii
Table 1. Continuation Implications of Lump Sum Option ... 32
Table A-1. Empirical Estimates of Discount Rates ... A-3
Table A-2. Characteristics of Choices in the Drawdown ... A-10
Table A-3. Nominal PDR Estimates Based on Drawdown Program ... A-12
Table A-4. SWP Estimates of Expected and Median PDRs by Demographic Group ... A-17
Table A-5. Choice of Retirement Alternative in 2004 Status of Forces Survey ... A-21
Table A-6. Estimates of the PDR Distribution Based on August 2004 Status of Forces Data ... A-23
Table B-1. Summary of Discount Rates in the Four Scenarios ... B-10
Table B-2. Marginal Tax Rates and After-Tax Breakeven Discount Rates for Lump Sum Distributions ... B-11

Table B-3. Overall Before-Tax (BT) and After-Tax (AT) Take Rates by DoD Discount Rate (*g*) Used To Determine Lump Sum Amounts B-12
Table B-4. DoD Retirement Liability by PDR Scenario Based on After-Tax Breakeven Rates, and Awareness of VA Offset Provisions B-13
Table B-5. Savings by Scenario Based on After-Tax Breakeven Rates and Awareness of VA Offset Provisions (Millions) B-14
Table C-1. FY 2015 Retiree Cohort Statistics C-1
Table C-2. Basic Calculations Involving Retired Pay under Modernized Military Retirement System C-2
Table C-3. Average Lump Sum (LS) Amounts and Implied Tax Liabilities at Various DoD Discount Rates (g), All Retirees C-2
Table D-1. Coefficients in Equations for Log-Income and Log-PDR D-2
Table E-1. Distribution of CDRs in the Recent Non-Retiree Cohort and in Recent Retiree Veteran Cohort E-2
Table E-2. Coefficients in a Multinomial Logit Model of Service-Connected Disability Rating E-3
Table G-1. Factors Involved in the Expected Returns to Staying in Service, Leaving Service, and the Retention Decision G-4
Table G-2. Historical Annual Continuation Rates Compared to Model Fits u nder Current Compensation System G-11
Table G-3. Historical Survival to Various Career Points Compared to Model Fits G-15
Table G-4. Effects of Pay Changes on Retention in Current Compensation System G-16
Table G-5. Effects of Pay Changes on Survival in the Current Compensation System G-18
Table G-6. Retention Effects of the BRS without the Lump Sum (LS) Option G-20
Table G-7. Effects of the BRS without the Lump Sum Option on Survival G-21
Table G-8. BRS Retention without the Lump Sum Option and Changes Due to the Option at GDRs of 2.5%, 5%, and 7.5% (Unaware of Tax Effects and VA Offsets) G-24
Table G-9. BRS Retention without the Lump Sum Option and Changes Due to the Option at GDRs of 2.5%, 5%, and 7.5% (Aware of Tax Effects and VA Offsets) G-25
Table G-10. BRS Survival without the Lump Sum Option and Changes Due to the Option at GDRs of 2.5%, 5%, and 7.5% (Unaware of Tax Effects and VA Offsets) G-26
Table G-11. BRS Survival without the Lump Sum Option and Changes due to the Option at GDRs of 2.5%, 5%, and 7.5% (Aware of Tax Effects and VA Offsets) G-27
Table G-12. Person-Years per Accession G-29

Table J-1. Predicted Percentages of Personnel Making Voluntary Contributions to the Federal Thrift Savings Plan J-1
Table J-2. Percent of Personnel in CSB/REDUX Study Database Enrolled in FTSP by YOS Interval in the Year of Observation, FY 2002–2008 ....J-2

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Abbreviations

AAA	American Academy of Actuaries
ACS	American Community Survey
AEW	Annuity Equivalent Wealth
AFQT	Armed Forces Qualification Test
AIRI	Annuity Interest Rate Index
ASD(M&RA)	Assistant Secretary of Defense for Manpower and Reserve Affairs
AT	After Tax
BER	Breakeven Rate
BP	Basic Pay
BRS	Blended Retirement System
BT	Before Tax
CDR	Combined Disability Rating
CPI	Consumer Price Index
CSB	Career Status Bonus
DMDC	Defense Manpower Data Center
DoD	Department of Defense
DR	Discount Rate
DRM	Dynamic Retention Model
ERL	Expected Return to Leaving
ERS	Expected Return to Staying
ETS	Expiration of Term of Service
EWG	Executive Working Group
FTSP	Federal Thrift Savings Plan
FY	Fiscal Year
GDR	Government Discount Rate
IDA	Institute for Defense Analyses
IDS	Interactive Data System
IML	Interactive Matrix Language
IRC	Internal Revenue Code
LS	Lump Sum
MCRMC	Military Compensation and Retirement Modernization Commission

MLM	Multinomial Logit Model
MRF	Military Retirement Fund
NASRA	National Association of State Retirement Administrators
NDAA	National Defense Authorization Act
PDR	Personal Discount Rate
POS	Period(s) of Service
PPA	Pension Protection Act
PYPA	Person-Years per Accession
RMC	Regular Military Compensation
SAS	Statistical Analysis System
SFFAS	Statement of Federal Financial Accounting Standards
SOF	Status of Forces
SSB	Selective Separation Benefit
SWP	Simon, Warner, and Pleeter
VA	Department of Veterans Affairs
VSI	Voluntary Separation Incentive
WP	Warner and Pleeter
YOS	Year(s) of Service

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
xx-11-2017	Final	Mar 2016 - Jun 2017

4. TITLE AND SUBTITLE
Discount Rate Analysis for Blended Retirement System Lump Sum Payments

5a. CONTRACT NUMBER HQ0034-14-D-0001
5b. GRANT NUMBER
5c. PROGRAM ELEMENT NUMBER
5d. PROJECT NUMBER
5e. TASK NUMBER BE-7-4151
5f. WORK UNIT NUMBER

6. AUTHOR(S)
Horowitz, Stanley, A.
Tate, David, M.
Warner, John, T.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Institute for Defense Analyses
4850 Mark Center Drive
Alexandria, VA 22311-1882

8. PERFORMING ORGANIZATION REPORT NUMBER
IDA Paper P-8527
Log: H 17-000322

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Assistant Director, Compensation Policy
Office of the Under Secretary of Defense for Personnel and Readiness
The Pentagon, Room 3D1067
Washington, DC 28310-0001

10. SPONSOR/MONITOR'S ACRONYM(S) OUSD (P&R)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The Fiscal Year (FY) 2016 National Defense Authorization Act modified the military retirement system. The new system, called the Blended Retirement System (BRS) allows retiring personnel to convert a part of their retirement annuities to a lump sum, receivable at retirement. The Secretary of Defense must determine the discount rate to use in calculating the lump sums. The Director for Military Compensation, Office of the Assistant Secretary of Defense (Manpower and Reserve Affairs) asked the Institute for Defense Analyses to perform analytical tasks to help determine the discount rate. These tasks included:
• Reviewing the literature regarding the personal discount rates (PDRs) of military personnel. The two most relevant studies find mean real PDRs of roughly 5.7 percent in one case and 12.5 percent in the other.The lower mean rate is likely more relevant.
• Reviewing other sources of information on discount rates used for making similar calculations of lump sum payments in lieu of a stream of deferred payments. Lotteries use real discount rates of under 1 percent. Rates used in private pension conversions are below 2 percent. State government plans use rates as high as 6.5 percent.
• Estimating the proportion of Active Duty and Reserve personnel expected to opt for a lump sum distribution at retirement, as a function of the discount rate selected by the government. At government discount rates (GDRs) around 3 percent, the take rate could be between 30 and 60 percent, depending on the PDR distribution. Take rates fall rapidly as the GDR rises.
• Estimating the cost implications to the government of the choice of discount rate used to compute lump sum equivalents. Savings could be as high as $1.05 billion relative to a BRS system not offering a lump sum option.
• Estimating the effect of the choice of discount rate on retention behavior of officer and enlisted personnel. We estimate the effect to be small, but there could be a non-negligible drop in retention beyond 20 years of service.
• Characterizing and quantifying the pros and cons of alternative methods for selecting discount rates to be used to compute lump sum equivalents.

15. SUBJECT TERMS
military retirement; retirement; blended retirement system; BRS, discount rate; personal discount rate; lump sum payment; second career annuity

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
Unclassified	Unclassified	Unclassified	Same as Report	143	Corso, Andrew
					19b. TELEPHONE NUMBER *(Include area code)* (703) 693-1059

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