The Personal Discount Rate: Evidence from Military Downsizing Programs

By JOHN T. WARNER AND SAUL PLEETER*

The military drawdown program of the early 1990's provides an opportunity to obtain estimates of personal discount rates based on large numbers of people making real choices involving large sums. The program offered over 65,000 separatees the choice between an annuity and a lump-sum payment. Despite break-even discount rates exceeding 17 percent, most of the separatees selected the lump sum—saving taxpayers $1.7 billion in separation costs. Estimates of discount rates range from 0 to over 30 percent and vary with education, age, race, sex, number of dependents, ability test score, and the size of payment. (*JEL* D91)

The rate at which individuals trade current for future dollars, or personal discount rate, is a provocative subject with important implications for many aspects of economic behavior and public policy.

In this paper we report the results of a natural experiment that provides a unique opportunity to measure personal discount rates that resulted from the U.S. military drawdown program beginning in January 1992. The U.S. Department of Defense (DoD) began offering two separation benefit packages to mid-career military personnel in selected occupations that consisted of a choice between a lump-sum separation benefit or an annuity.

We observe the separation payment choices of 11,000 officers and 55,000 enlisted personnel who faced before-tax break-even discount rates (the rate which equated the present value of the annuity with the value of the lump-sum payment) of between 17.5 and 19.8 percent. Based on conventional interest rates, economists in DoD predicted, prior to implementation of the program, that about half of the enlisted personnel, but virtually no officers, would take the lump sum rather than the annuity. In fact, over half of the officers and over 90 percent of the enlisted personnel took the lump-sum payment, implying that the vast majority of personnel had discount rates of at least 18 percent. Since government borrowing rates are far below these personal discount rates, we estimate that offering lump-sum payments saved taxpayers $1.7 billion in severance costs.

We believe that the evidence from our analysis is more compelling than some of the previous evidence about personal discount rates for two reasons. First, the choices are real, not hypothetical, and involve decisions over quite large sums. The typical officer faced a choice over an annuity versus a lump sum worth close to $50,000. The typical enlisted choice involved a lump sum of approximately $25,000. These are generally much larger sums than those involved in previous nonexperimental studies. Second, unlike many past studies, which have been based on experiments with college students or analyses of low-income populations, our data are representative of different segments of the U.S. population. Whereas 24.5 percent of individuals aged 25–35 in the March 1992 and March 1993 *Current Population Surveys* have a college education or better, virtually all of the officers in our data do. Officers comprise about 20 percent of our sample. The rest of our

* Warner: Department of Economics, 222 Sirrine Hall, Clemson University, Clemson, SC 29634; Pleeter: Office of the Undersecretary of Defense for Personnel and Readiness, Compensation Directorate, Room 2B279, U.S. Department of Defense, Pentagon, Washington, DC 20301, and American University. We thank Dan Benjamin, Gene Devine, Bill Dougan, Matt Goldberg, Stan Horowitz, Richard Ippolito, Matt Lindsay, Bruce Lintner, Walter Oi, Sherwin Rosen, Curtis Simon, Robert Tamura, Chris Thornberg, Myles Wallace, an anonymous referee, and seminar participants at American University for comments on previous drafts. Special thanks are due Terry Cholar of the Defense Manpower Data Center for assembling the data set used for this study. We are responsible for any remaining errors.

sample is comprised of enlisted personnel, among whom the modal educational level is a high-school degree, which is also the modal degree of individuals aged 25–35 in the March 1992 and March 1993 *Current Population Surveys* (37 percent). In terms of earnings, military officers have about the same taxable earnings as male civilians aged 25–35 with a college degree and the enlisted personnel have about the same earnings as civilian male high-school graduates in the 25–35 age range. In terms of educational achievement and earnings, our data are representative of different segments of the U.S. population.

After describing the drawdown programs in Section I, Section II reviews the relevant literature in more detail. Then Section III presents our analysis of the drawdown data. Section IV concludes the paper.

I. Drawdown Programs

In light of the collapse of the Soviet Union and lesser need for a large standing military force, the 1991 Defense Authorization Act directed DoD to reduce active duty strength by 400,000 by FY 1995, a 25-percent reduction. To maintain a balanced force, reductions would have to come from every experience level, including career personnel not yet vested in the military retirement system, which "cliff-vests" at 20 years of service. Congress also directed that involuntary separations of career members be minimized.

To assist DoD in attaining this voluntary reduction, two temporary financial incentive programs were developed: the Voluntary Separation Incentive (VSI) and the Selective Separation Benefit (SSB). The VSI program provided an annuity to the separating member equal to 2.5 percent of annual basic pay multiplied by the member's years of service (YOS). Payments were to be received for a period equal to twice the member's YOS. The VSI formula is similar to that for determining military retirement benefits. But, unlike military retirement benefits, the VSI annuity was not indexed for inflation. The SSB program provided a lump-sum payment of 15 percent of annual basic pay multiplied by the member's YOS.

Although VSI payments were not assignable (transferable), the payments continue to designated beneficiaries in the event of the member's death. Both the annuity and the lump-sum payment are taxable in the year received. As we show below, the lump-sum payment is likely to be taxed at a higher marginal rate than the annuity, or the same rate at best.

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 needing further clarification. The pamphlets contained comparisons between the lump-sum SSB and the present value of the annuity for selected grades and YOS. Discounting was done using a nominal 7-percent interest rate, the rate being paid for money market funds in 1991. At this discount rate, the annuity compared quite favorably with the lump sum, as Table 1 illustrates. The table provides illustrative examples of the lump-sum amounts offered officers and enlisted personnel in some of the larger rank/YOS groupings affected by the program. Annuity amounts and present values using DoD's assumed 7-percent discount rate are also shown. At this discount rate, the present value of the annuity was in many cases more than double the value of the lump-sum payment.

Table 1 also shows the present value of the annuity at discount rates of 10, 20, and 30 percent, respectively. At discount rates of 20 or 30 percent, the lump-sum amount exceeds the present value of the annuity. In these comparisons, which do not account for the tax consequences of the choices, break-even discount rates range from 17.5 percent for those with 7 years of service to 19.8 percent for those with 15 years of service. Apparently, personnel did not find DoD's information pamphlet, with its comparison of the two separation choices, very convincing. Among the officers with less than 10 years of service, *more than half* took the lump sum. Among the E-5 enlisted personnel with less than 10 years, *over 90 percent* did so. Almost 75 percent of E-7 enlisted personnel with 15 years of service 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 (see Table 2).

TABLE 1—VSI AND SSB BENEFITS, SELECTED EXAMPLES

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

TABLE 2—NUMBER ELIGIBLE FOR SEPARATION PAYMENTS, NUMBER SEPARATING, AND NUMBER CHOOSING SSB

	Army	Navy	Air Force	Total
		Officers		
Eligible	26,159	9,777	23,272	59,208
Separated	6,447	645	4,120	11,212
	(24.7)	(6.6)	(17.7)	(18.9)
Lump sum	3,459	401	1,854	5,714
	(53.7)	(62.2)	(45.0)	(51.0)
				Enlisted
Eligible	76,118	38,794	120,040	234,952
Separated	24,213	9,235	21,823	55,271
	(31.8)	(23.8)	(18.2)	(23.5)
Lump sum	22,994	8,080	19,802	50,876
	(95.0)	(87.5)	(90.7)	(92.1)

The evolution of the drawdown programs is interesting. In July of 1991, DoD submitted a bill to Congress requesting authorization of the VSI. DoD's proposal would have allowed separatees who did not want to receive their separation benefits in annuity form to sell their annuities in the private market. Congress balked at this idea, and an impasse prevailed between DoD and the Congress for several months. At the last minute, the Congress included a provision in the FY 1992 Defense Authorization Act allowing separatees to take a lump-sum payment of 1.5 times the payment for involuntary separation in lieu of the annuity proposed by DoD.[1] (It is fortunate that the Congress inserted the SSB option, because it set up the natural experiment that we analyze!) Personnel who took the lump sum were also to receive all the other separation benefits available to involuntary separatees, such as medical benefits,

[1] The lump-sum alternative was devised by Fredrick Pang, a retired Air Force Colonel who at the time was the staff director of the Senate Armed Services Committee. Colonel Pang was familiar with previous military manpower research suggesting high personal discount rates among military personnel.

moving and furniture storage expenses, etc. The act also adopted DoD's VSI proposal along with DoD's provisos relating to other benefits available to VSI recipients.

Unfortunately for the VSI recipients, all other aspects of the choice favored the SSB. VSI required an affiliation with a reserve component for the life of the payment whereas SSB required only a three-year commitment in the Ready Reserve.[2] Transition benefits associated with SSB included extended commissary and exchange privileges, 60- to 120-day extension of medical coverage, shipment of household goods, and possible extension of military housing. VSI had none of these transition benefits. In terms of possible civil service employment, SSB allowed the member to count military service toward federal civil service retirement whereas VSI would not allow military service to be counted toward federal civil service retirement. Because of these additional considerations, inferences about personal discount rates from the FY 1992 data alone would be clouded. Even if a person had a low discount rate, he or she might be induced to select the SSB because of the higher value of the other benefits associated with that choice. Recognizing in retrospect the disadvantages that DoD's plan placed on VSI recipients, the FY 1993 Defense Authorization Act authorized VSI recipients the same separation benefit package as that provided to SSB recipients. Therefore, for those separating after the start of FY 1993, any choice of annuity/lump-sum programs would be based upon the financial characteristics of the two choices.[3]

II. Past Studies of the Personal Discount Rate

Over the past two decades, economists and psychologists have devoted considerable effort to the measurement of the personal discount rate (D).[4] Experimental studies (see Richard H. Thaler, 1981; Matthew Black, 1984; Uri Benzion et al., 1989) have confronted subjects (often college students) with hypothetical intertemporal choices and estimated D from the choices. Nonexperimental studies (Harry J. Gilman, 1976; Jerry A. Hausman, 1979; Dermot Gately, 1980; Steven Cylke et al., 1982; Henry Ruderman et al., 1986) have attempted to infer the personal discount rate from actual rather than experimental choices.

These studies offer three general findings. First, individuals do not discount all future values at the same rate. Experimental studies by Thaler (1981) and Benzion et al. (1989) have found D to be higher for hypothetical choices involving relatively small sums. This result seems to be corroborated in inferential studies. Hausman (1979) inferred personal discount rates by comparing appliance purchases—a reference model compared with more energy-efficient models. A "break-even" discount rate was calculated based on capital cost and energy-saving differences. Hausman estimated an average personal discount rate of about 25 percent. Gately (1980) studied purchases of refrigerators and found even larger discount rates. Studying purchases of various appliances, Ruderman et al. (1986) estimated discount rates ranging from 17 to 243 percent depending upon type of appliance. Ignorance, illiquidity, and shortened "payback" periods were offered as explanations for such high rates.

Cylke et al. (1982) examined the differential impacts of lump-sum and installment bonuses upon the propensity of Navy enlisted personnel to reenlist and inferred discount rates of 15 to 18 percent from the stronger reenlistment effect of lump-sum bonuses. Gilman (1976) inferred personal discount rates from the propensity of employees of four nonprofit organizations to participate in their

[2] Individual Ready Reserve members are not required to participate in monthly drills, but may be activated during an emergency.

[3] Note that many FY 1993 separatees may have decided to leave in FY 1992. Although separatees were asked to make a separation benefit choice at the time they announced their separation decision, DoD permitted switching between VSI and SSB up to the date of actual separation.

[4] In the standard neoclassical model of intertemporal choice, $D = MRTP - 1$, where $MRTP$ is the individual's marginal rate of time preference at the utility-maximizing mix of current and future consumption. D is distinct from the pure rate of time preference, which equals $MRTP - 1$ measured at equal amounts of current and future consumption along the individual's intertemporal budget constraint (Emily C. Lawrance, 1991).

organization's retirement plan. He estimated personal discount rates ranging between 8.5 and 16.2 percent for one model specification and between 1.3 and 19.6 percent for another.[5] Black (1984) estimated discount rates from survey questions about alternative retirement systems for the military. In this survey, military personnel were asked a series of questions regarding preferences for alternative hypothetical military retirement plans. He estimated an average discount rate of 10.3 percent for officers and 12.5 percent for enlisted personnel. The generally lower estimates of *D* obtained in the latter three studies than in the appliance purchase studies may be due to the fact that the individuals in the latter studies were making choices over significantly larger sums.

A second finding from earlier studies is that *D* varies with the time delay of the reward or penalty. Individuals appear to discount future amounts hyperbolically, applying higher discount rates to amounts with a short delay than to amounts to be received farther into the future (see, e.g., Thaler, 1981; Benzion et al., 1989; and the literature review by George Ainslie and Nick Haslam, 1992).

Third, there is evidence that *D* varies with income and other personal characteristics. Both Gilman and Black found that personal discount rates decline with income, education, and age. They also found that blacks have higher discount rates than whites.[6] However, results with respect to gender and marital status were mixed.

Why personal discount rates might be related to personal attributes is not entirely clear. In the standard neoclassical model with perfect capital markets, utility-maximizing agents borrow or lend until *D* equals the market rate of interest for borrowing or lending (*R*). If different individuals face different borrowing or lending rates, *D* will be correlated with personal attributes to the extent that such attributes affect *R*. For example, more-educated, higher-income individuals may be able to borrow at lower rates than less-educated, lower-income individuals. And to the extent that blacks and other minorities face discrimination in credit markets, they will face higher borrowing rates and therefore exhibit higher personal discount rates. *D* might also decline with age if lenders perceive older individuals to be better credit risks than younger ones.

When capital markets are imperfect, personal attributes could affect personal discount rates through their influence on intertemporal preferences. One such imperfection is the existence of borrowing constraints. In the presence of borrowing constraints, individuals will be unable to expand current consumption (at the expense of future consumption) to the point where *D* equals *R*. *D* will exceed *R* at the observed mix of current and future consumption.[7] In such a case, *D* could be related to personal attributes such as education because these factors have directly shaped preferences for current versus future consumption or because they are related to preferences through previous choices. For example, more education might reduce *D* directly by helping people better understand intertemporal choice and delay immediate gratification for future rewards. But education might be negatively associated with *D* simply because more patient individuals acquired more education in the past.

Identifying why *D* varies with personal attributes is beyond the scope of this paper. Our goal is more modest—estimate reduced-form relationships between *D* and various personal attributes and other factors with data from the drawdown experiment. We now turn to our model and the empirical analysis.

[5] Two of the organizations were the Center for Naval Analyses and the University of Rochester. The other two could not be disclosed for confidentiality reasons.

[6] Lawrance (1991) estimated pure rates of time preference from *Panel Survey of Income Dynamics* data on food consumption. She found the pure rate of time preference to vary with education, age, and race. Estimates ranged from 12 percent for college-educated whites in the top 5 percent of the income distribution to 19 percent for nonwhites without a college education in the bottom fifth of the income distribution.

[7] Stephen P. Zeldes (1989) finds evidence that those with low wealth are more likely to be liquidity constrained than those with more wealth. If those with low wealth are more likely to be liquidity constrained, a finding that they have higher personal discount rates than more wealthy individuals could reflect differences in preferences for current versus future consumption as well as differences in the market interest rates the two groups face.

III. Analysis of the Drawdown Data

A. *Probit Model of the Separation Payment Choice*

Our statistical procedure was suggested in the discount-rate studies by Gilman and Black, although they did not or could not fully implement the procedure. Orley Ashenfelter (1983) employed the same procedure to study program participation and earnings in the Negative Income Tax experiments of the 1970's. Let D^* denote the break-even discount rate, i.e., the rate that equates the after-tax value of the SSB lump sum with the after-tax present value of the VSI annuity. Individuals choose the lump sum if $D > D^*$ and the annuity otherwise. The break-even rate D^* is the discount rate such that

$$(1a)\quad (1 - t_1)SSB = \Sigma_{t=0}^{2YOS-1}(1 - t_2)A(1 + D^*)^{-t}$$

where SSB is the lump-sum payment, t_1 is the tax rate applied to the SSB, A is the annuity amount, and t_2 is the tax rate applied to the annuity amounts. But since $SSB = 0.15 \times YOS \times$ final basic pay and $A = 0.025 \times YOS \times$ final basic pay, the break-even discount rate solves

$$(1b)\quad 6\,\frac{(1 - t_1)}{(1 - t_2)} = \Sigma_{t=0}^{2YOS-1}(1 + D^*)^{-t}.$$

D^* was calculated for each individual in the sample. To do so, we estimated the marginal tax liability associated with each choice using the tax tables in effect at the time of separation and assuming that individuals take the standard deduction based on their family size. The tax rates in equations (1a) and (1b) are ratios of the respective tax liabilities to separation payment. Calculations were made assuming that the same marginal tax bracket would be maintained after separation. Earnings were imputed to the spouses of married personnel based on results of a 1992 survey of earnings of military spouses. The average marginal tax rate on annuity income was calculated to be 16.8 percent while the average tax rate on the lump sum was calculated to be 19.9 percent.[8]

Because the payout period rises with YOS, D^* rises with the military member's years of service. It also varies with the marginal tax rates to which the two payments would be subject. D^* increases with the difference between the two tax rates, as is the case with individuals with greater income and for single personnel. The sample average value of D^* is 19.8 percent.

Individuals choose the SSB if $D > D^*$ and VSI otherwise. To model the VSI/SSB choice formally, let D be a linear function of the observed characteristics of the individual (X) and random error (ε)

$$(2)\qquad D = X\boldsymbol{\beta} + \varepsilon$$

where $\boldsymbol{\beta}$ is a parameter vector. We assume that $\varepsilon \sim N(0, \sigma^2)$. Of course, D cannot be directly observed. But it can be estimated as follows. Since individuals select the lump-sum SSB payment if $D > D^*$, they choose SSB if $X\boldsymbol{\beta} + \varepsilon > D^*$ or $X\boldsymbol{\beta} - D^* > -\varepsilon$. The probability of choosing the lump-sum payment is given by:

$$\begin{aligned}(3)\quad P(SSB) &= P(X\boldsymbol{\beta} - D^* > -\varepsilon)\\ &= P\left(X\frac{\boldsymbol{\beta}}{\sigma} - \frac{1}{\sigma}D^* > -\frac{\varepsilon}{\sigma}\right)\\ &= P(X\boldsymbol{\delta} - \alpha D^* > \xi)\\ &= \Phi(X\boldsymbol{\delta} - \alpha D^*)\end{aligned}$$

where $\boldsymbol{\delta} = \boldsymbol{\beta}/\sigma$, $\alpha = 1/\sigma$, $\xi = -\varepsilon/\sigma$, and $\Phi(\cdot)$ denotes standard normal distribution function. Since ξ is standard normal, equation (3) is an ordinary probit model. Unlike usual probit models, in which parameters of equations underlying the choice [e.g., equation (2)] can only be estimated up to a scale factor, the underlying

[8] Most enlisted personnel were in the 15-percent federal tax bracket and would stay there whether they took the annuity or the lump sum. The more highly paid officers were in higher marginal brackets and for them the marginal tax rate on the lump sum was higher.

parameters $\boldsymbol{\beta}$ and σ are identified from estimates of $\boldsymbol{\delta}$ and α.[9]

A disadvantage of the linear formulation is that it permits individuals to have negative discount rates. A lognormal model would restrict D to be strictly positive. Let $D = \exp\{X\boldsymbol{\beta}\}*\exp(\varepsilon)$ where $\varepsilon \sim N(0, \sigma^2)$. The expected discount rate is $E(D) = \exp\{X\boldsymbol{\beta} + 0.5\sigma^2\}$ and the standard deviation is $E(D)(\exp\{\sigma^2\} - 1)^{1/2}$. As before, individuals choose the lump sum if $D > D^*$, or in this case $X\boldsymbol{\beta} + \varepsilon > \ln D^*$. In addition to the imposition of strictly positive discount rates, the lognormal model differs from the linear model in that the effect on $E(D)$ of changes in X is not constant but depends on the level of X.

B. *Regressors*

Section II discussed reasons why personal discount rates might be associated with personal attributes such as income, education, age, sex, race, and marital status. Our empirical models include most of the same variables included in past studies. One is the military member's wage or income (*WAGE*). In the analysis below, *WAGE* is the individual's total taxable military pay plus allowances in the calendar year preceding separation. *WAGE* should be negatively related to the likelihood of choosing the SSB and to D for reasons discussed earlier. However, because military human capital may not be very transferable to the private sector (Matthew S. Goldberg and Warner, 1987), the military wage may not be a very good indicator of an individual's permanent private-sector earnings capacity.

Permanent earnings capacity is probably better measured by education, which is also expected to be negatively related to the likelihood of choosing the SSB and to D. The officer models presented below include dummies for graduate education and for college degree. The enlisted models include dummies for some college education (or better) and for high-school degree. Age is included in the model and, due to the limited age range of the individuals in our data (about 25 to 35), is expected to be negatively related to the likelihood of choosing the SSB.

D may be related to mental test score as well as education. If individuals who score better on mental tests have higher earning capacity, D will be negatively related to measures of mental ability through the effect of test scores on earnings (see, e.g., Derek A. Neal and William R. Johnson, 1996). In addition, individuals scoring better on mental tests may be better able to process information and understand intertemporal choices. To control for test-score effects in the enlisted models we included three standard measures based on entry test score—mental group I [score of 94 or above on the Armed Forces Qualification Test (AFQT)], mental group II (65–93 on the AFQT), and mental group IIIA (50–64 on the AFQT). The omitted group consists of individuals scoring below 50 on the AFQT. Unfortunately, no test-score measure is available for officers.

Other demographic controls include dummies for race (black, white) and sex (female) and the number of dependents. To the extent that borrowing opportunities vary by race, or that race is a proxy for permanent (as opposed to current) income, the VSI/SSB choice, and thus the personal discount rate, will vary by race. We have no priors about the effect of gender, and previous studies have yielded mixed results about the relationship between gender and D.

Although there has been little work on the relationship between family size and D, a model of human-capital investment decisions, fertility, and economic growth by Gary S. Becker et al. (1990) relies on the *assumption* of a positive relationship. In their analysis, parents who discount the future more highly have more children and invest less in each one. However, there is no existing evidence about the relationship between family size and discount rates, so our estimates are the first.

D might vary with one's military occupation. One reason is that individuals who discount the future more highly may be attracted to the

[9] Gilman estimated equation (2) excluding D^* and had to assume a value of σ in order to estimate D. He assumed it to be 0.06. Because D^* was correlated with included regressors, Gilman's estimates were biased due to the exclusion of D^*. In Black's survey data there was no variation in D^*, so it could not be included as a regressor. He inferred values of σ from (seemingly arbitrary) subsidiary analyses and found it to be about 0.04 to 0.06. An improvement of our study is that we can actually estimate σ.

military skills that offer more up-front pay and benefits at entry. Such skills also tend to be the more dangerous (e.g., combat arms), so occupational differences in *D* might also reflect differences in attitudes towards risk. To the extent that military occupation is a surrogate for future civilian employment opportunities, and, therefore, permanent income, we would expect *D* to vary with military occupation.

According to several studies cited in Section II, people discount future benefits hyperbolically. Hyperbolic discounting means that the discount rate applied to each future amount in equation (1a) or (1b) will be dependent upon time and furthermore that the near-term amounts will be discounted more heavily, and far-term amounts less heavily, than would be implied by discounting at a constant rate. It would be impossible to estimate a whole time profile of discount rates. But note that because of the construction of the VSI/SSB program, people with more years of service who select the annuity will receive that annuity over a longer time span and will thus have to wait longer to receive the "average" dollar of annuity payment. If hyperbolic discounting is present, then holding constant age and D^*, YOS will affect *D* to the extent that it measures the average delay in receiving annuity payments. If it is present, *D* should fall with YOS.

It should be pointed out that the VSI was not indexed to inflation, as is the standard military retirement annuity. Therefore the discount rates that we estimate are nominal rates and not real ones. Even those individuals with very low real discount rates could have been induced to select the SSB if they expected high future inflation. Although we cannot observe the inflationary expectations of the individuals in our data, we doubt that expectations of high or accelerating future inflation were influencing their choices. The inflation rate averaged about 3 percent during 1991–1992 and inflation over the period 1988–1992 averaged 4.2 percent. It is likely that individuals were anticipating inflation rates in the range of 3–4 percent when they were making their payment choice decisions.[10]

C. *Sample Selection Issues*

Since the sample of individuals who made separation payment choices is observed only for those who actually separated, an analysis that ignores the separation process may suffer from the problem of sample selection bias. A priori, it is not obvious which way the sample selection bias will go. If the drawdown program had been strictly voluntary, the selection bias would most likely be positive. In an environment of voluntary retention decisions on the part of service members, each individual would make a stay-leave decision based on the expected present value of future income from a stay decision with the present value of a leave decision (Thomas Daula and Robert Moffitt, 1995). Because current period pay tends to be lower in the military than the private sector, and because military retired pay is only vested after 20 years of service, military compensation is more heavily deferred than private-sector compensation. The system is therefore more attractive to individuals with low discount rates. Consequently, stayers will tend to be individuals with lower discount rates while leavers will tend to have higher discount rates. Discount rates estimated from a sample of leavers would, in an environment of fully voluntary retention decisions, overstate the mean discount rate in the whole military population. That is, the selection bias would be positive.

On the other hand, retention decisions in the environment of the military drawdown were not strictly voluntary. Personnel in the Army and Air Force who were in skills selected for separation payments were told that if separation rates in those skills were not high enough with the voluntary payments, they would be subject to involuntary separation. Navy personnel were not so threatened.[11] Furthermore, at the start of the drawdown, the services imposed up-or-out

[10] Some recent analyses of inflation suggests that inflation is integrated of order 1 (I(1)) and requires first-differencing to be stationary (see, e.g., Myles S. Wallace and Warner, 1993). Since inflation is I(1), if individuals use the time-series properties of past inflation to forecast future inflation, the previous period's inflation rate will eventually dominate the long-run forecast.

[11] Recall that the SSB payment was set at 1.5 times the involuntary separation payment. The regret for a person with 10 years of service who did not separate and was subsequently involuntarily separated was half a year's basic pay (if the person opted for the lump sum).

rules on nonretirement-eligible personnel which previously did not exist. The Army, for instance, imposed mandatory separation rules on enlisted personnel in the rank of E-4 who had more than 8 years of service and E-5's with more than 13 years of service. Previously, such personnel were mandatorily separated only upon completion of 20 years of service. As another example, although Captains usually get two chances at promotion to Major before facing involuntary separation, Army and Air Force Captains who had failed their first chance at promotion to Major were told that they had to leave. In such an environment, where mid-career personnel are confronted with the sudden imposition of tighter standards for continuation, cohorts of separatees are likely to be comprised of numerous individuals with low discount rates as well as individuals with high rates.

The problem of selection bias is handled with a bivariate probit model with partial observability (William H. Greene, 1997 p. 912). Let $S^* = Z\boldsymbol{\gamma} + u$ be an index function for the net value of separation, where Z is a vector of regressors, u is a standard normal random error, and where $S = 1$ if separation occurs and 0 if it does not. Estimates of the separation payment choice equation are biased if the residuals in the separation equation (u) and the separation payment choice equation (ε/σ) are correlated. Consistent maximum-likelihood estimates may be obtained by estimating the separation and payment choice equations jointly, allowing for correlation between u and ε/σ.

D. *Summary Statistics*

Data for our analysis were provided by the Defense Manpower Data Center (DMDC). At the start of the drawdown, DoD instructed the services to provide DMDC with a report on each service member's eligibility on a quarterly basis along with information about each member's actual separation under the program. Our data set is a match of (1) the service reports of eligibility, (2) DMDC's master file records containing information about race, sex, education, rank, years of service, etc., and (3) Joint Uniform Military Pay System (JUMPS) records containing information about each service member's military compensation and the separation payment actually received. The Air Force and the Navy complied with reporting requirements. Unfortunately, the Army and the Marine Corps only reported actual separations under the program and failed to report each member's eligibility. We were able to construct a variable for eligibility of Army personnel based on criteria for eligibility that the Army published and distributed periodically during the drawdown. Unfortunately, we could not repeat this procedure for the Marine Corps, which is therefore deleted from the analysis. But because it is a small service and had few separatees receiving separation payments, we do not lose much information by ignoring the Marine Corps.

Approximately 59,000 officers and 235,000 enlisted members in the Army, Navy, and Air Force were eligible to participate in the program in fiscal years 1992 and 1993. Table 2 shows the base number eligible in each service, the number (and percent) separating, and the number (and percent) selecting the lump-sum option. Overall, 18.9 percent of eligible officers separated under the program and 23.5 percent of eligible enlisted personnel separated. Of those separating, about half of the officers chose the lump sum while over 90 percent of the enlisted personnel did so. Means of the variables used in the empirical analysis are provided in Appendix Table A1.

E. *Point Estimates of Personal Discount Rates*

Estimates of a single discount rate may be obtained by estimating a simple probit model for the sample of separatees with D^* as the only regressor. Three simple probit models are reported in Panel A of Table 3, a model that pools the officer and enlisted separatees together and models for each group separately. Tax adjustment of break-even discount rates introduces more variation into D^* than exists in the non-tax-adjusted values, so it is of interest to know how sensitive the estimated coefficients on D^* (and consequently estimates of σ) are to tax adjustment. Panel A of Table 3 reports models with tax-unadjusted and tax-adjusted break-even rates, respectively. The implied personal discount rate is the product of the intercept and the inverse of the coefficient on D^*.

For interest, Panel B of Table 3 provides linear probability model estimates of the

TABLE 3—SIMPLE PROBIT AND LINEAR PROBABILITY MODELS OF SEPARATION PAYMENT CHOICE AND IMPLIED MEAN PERSONAL DISCOUNT RATE

	Pooled		Officer		Enlisted	
Variable	Parameter estimate	Standard error	Parameter estimate	Standard error	Parameter estimate	Standard error
			Panel A: Probit Models			
1. Without tax adjustment						
Intercept	5.320	0.186	7.553	0.308	10.240	0.304
D^*	−22.222	0.966	−39.530	1.614	−45.638	1.565
Sigma	0.045		0.025		0.022	
Log-likelihood	−27,688.84		−7,460.74		−14,844.03	
Sample size	66,483		11,212		55,271	
Mean discount rate	0.239		0.191		0.224	
2. With tax adjustment						
Intercept	4.549	0.104	2.307	0.212	6.579	0.140
D^*	−17.531	0.516	−11.463	1.064	−25.681	0.689
Sigma	0.057		0.087		0.039	
Log-likelihood	−27,372.87		−7,711.03		−14,599.53	
Sample size	66,483		11,212		55,271	
Mean discount rate	0.260		0.201		0.256	
			Panel B: Linear Probability Models			
1. Without tax adjustment						
Intercept	1.777	0.040	3.408	0.115	1.948	0.035
D^*	−4.823	0.209	−15.225	0.603	−5.340	0.182
R^2	0.008		0.054		0.015	
Sample size	66,483		11,212		55,271	
Mean discount rate	0.368		0.224		0.365	
2. With tax adjustment						
Intercept	1.631	0.023	1.411	0.212	1.644	0.019
D^*	−3.922	0.114	−4.529	1.064	−3.640	0.094
R^2	0.017		0.010		0.027	
Sample size	66,483		11,212		55,271	
Mean discount rate	0.416		0.312		0.452	

relationship between separation payment choice and D^*. The linear probability model is the appropriate functional form when personal discount rates are distributed uniformly. The linear probability model estimates of discount rates in Panel B are larger than the comparable Panel A probit estimates. The disparities in the discount-rate estimates are larger for enlisted personnel than for officers. This outcome was to be expected because estimates based on a uniform distribution will not deviate as much from estimates based on a normal distribution when the sample mean choice rate is 0.51 (officer case) than when the mean choice rate is 0.921 (enlisted case). Identification of the true underlying distribution would require observation of D, something we cannot do, but which Ashenfelter (1983) could for the analogous variable. Although it cannot be tested, the assumption of normality is inherently more plausible.

We now focus on Panel A of Table 3. In all models the probability of selecting the lump-sum payment is negatively related to the break-even discount rate. Coefficients on D^* using the tax-adjusted values of D^* are uniformly smaller, and estimates of σ consequently larger. In the enlisted case, the tax-adjusted estimate of σ (0.039) is almost double the unadjusted estimate (0.022). In the officer case, the tax-adjusted estimate is over three times larger (0.087 versus 0.025). Tax-unadjusted and tax-adjusted estimates of the personal discount rate are similar, 0.191 compared with 0.201 in the officer case and 0.224 compared with 0.256 in the enlisted case. That the discount rate would be this high was to be expected given that the break-even discount rates exceeded 17 percent and over half of the separatees still selected the lump sum. Recall that these are nominal rates. Based on an expected inflation rate of 3–4 per-

cent, the real rates implied by these estimates range from about 16 percent to 23 percent.

Estimates of the unobserved heterogeneity in personal discount rates are clearly sensitive to tax adjustment of the break-even discount rate. Which estimates are to be preferred? In the enlisted case the log-likelihood function value for the tax-adjusted model is higher than the log-likelihood value for the tax-unadjusted model. Unfortunately, in the officer case the reverse is true. Marginal tax rates on the lump-sum payments deviated more from the marginal tax rates on the annuities in the case of officers than in the case of enlisted personnel. It is therefore possible that more measurement error exists in the tax-adjusted estimates for officers than in the enlisted estimates and that the measurement error has the effect of biasing downward the estimated coefficient on D^* and overstating the unobserved heterogeneity. On the other hand, tax adjustment seems necessary because the tax-unadjusted estimates of σ are implausibly low in light of the high mean rates.

There is another reason why the estimates of σ reported in Table 3 are too low. D^* is correlated with several other observable variables that we find below to affect the personal discount rate (e.g., age and the size of the lump-sum payment). Inclusion of other variables reduced the coefficient on D^* and increased the estimates of σ. We also found in the enlisted case that estimates of σ were very close when we included other variables and that the log-likelihood function values were always higher for equivalently specified models with tax adjustment. In the officer case, estimates of σ rose in both tax-adjusted and tax-unadjusted models, but did not tend to converge as in the enlisted case. However, in the case of simple probit models of officer separation benefit selection, differences in the log-likelihood function value were virtually eliminated by inclusion of other variables. Furthermore, in the bivariate probit analysis of the officer data, the models with tax adjustment had higher log-likelihood values than models without tax adjustment. The tax-adjusted estimates seem more plausible than estimates without adjustment.

F. *Bivariate Probit Analysis*

1. *Separation Equation Estimates.*—The specification of the Z vector in the separation equation requires some discussion because identification of the model requires some variables in the separation equation that do not also appear in the payment choice equation. As implied by previous discussion, differences in service separation policies generated considerable variation in separation rates across the various service-rank-YOS groups. It is these policy-induced differences in separation rates that help identify the model. We capture these policy effects through a set of service-rank-YOS interactions in the separation equation. Thus, the officer separation equation includes 23 interaction variables between service (Army, Navy, Air Force), rank (O-3 and O-4), and YOS groupings (7–8, 9–10, 11–12, and 13–15).[12] The enlisted model contains 43 interactions between service, rank (E-4, E-5, E-6, and E-7), and YOS groupings.

Another policy-related separation variable is whether the individual was at the end of a contracted term of service (ATETS). As part of the drawdown, individuals who had not yet completed an enlistment were permitted to voluntarily separate with a payment. But the converse was not true—the services could not force individuals to leave prior to completion of the contracted enlistment. However, the services could refuse to retain individuals who had completed their contracted service. Thus, those still under an enlistment contract were afforded protection against an undesired separation not available to those whose contracts had expired. Again, we allow for cross-service differences by interacting ATETS with service. Along with the rank-service-YOS interactions, ATETS is an important identifier of the model because it clearly belongs in the separation equation, and there is no theoretical reason to believe that it should have a direct effect on the separation payment choice.[13]

Other variables in the separation equations included dummies for race, sex, education level, military occupation, geographic region, the number of dependents, and the military wage. The enlisted separation equation also included dummies for mental group. In the case of the

[12] One cell was empty. The Air Force had no O-4s in YOS 7–8.

[13] In fact, ATETS has virtually 0 coefficients and t-statistics when included in the separation payment choice equations.

officer model, we fully interacted these variables with dummies for service. To the extent that there exist cross-service differences in the effects of these variables upon separation, fully interacting these variables with service is a better specification of the separation equation. Because of computer limitations, in the case of the enlisted model we were only able to interact service with the military wage. The effects of other variables were thus constrained to be the same across services. Experiments with a subsample of the data indicated that the lack of interaction of these other variables and service had a negligible effect on the estimated separation payment choice equation and the estimated correlation of the residuals in the two equations.

Separation equations are reported in Appendix B, Tables B1 and B2. The coefficient on a particular service-rank-YOS combination forms the intercept for that combination. Differences across services in the application of drawdown policies are apparent in these intercept estimates. In the Army, for example, Captains with seven or eight years of service had a lower probability of separation than Captains with more experience. Since promotion from O-3 to O-4 occurs in the Army at around the 10- or 11-year mark, the O-3 separations in the higher YOS groups no doubt contained many who had been previously passed over for promotion. Among enlisted personnel, there exist quite different patterns in the probability of separation in the different service-rank-YOS groups. Among the lower-ranking groups (E-4–E-5) the probability of separation is either very flat or increasing as YOS increases; in the higher-ranking groups, the probability of separation declines as YOS increases.

Being at the end of a contracted period of service had a significant positive effect on the separation of Army officers, but not of Navy or Air Force officers. The lack of a significant effect was not surprising in the Navy case because the Navy was not forced to downsize to the same extent as the Army. The lack of a significant ATETS effect is somewhat puzzling in the case of Air Force officers. In the enlisted case, the ATETS effects are strongly supportive of a priori expectations. The probability of separation is higher for Army and Air Force personnel whose enlistment contracts expired in FY 1992–1993 than for personnel whose contracts did not expire in that period. Among Navy personnel, the estimated ATETS effect is insignificant.

Among Army officers and Army enlisted personnel the probability of separation is estimated to rise with the individual's military wage. But in the Navy it is estimated to decline. Among both Air Force officers and enlisted personnel, the probability of separation was independent of the military wage. That the probability of separation actually rises with wage in the Army but declines in the Navy is consistent with the fact that separation decisions were voluntary in the Navy but not in the Army. In the latter service, the more highly paid may have felt the possibility of future involuntary separation more acutely.

Demographic differences in the probability of separation were also apparent. Males have significantly lower probabilities of separation in all cases. Those with more education generally have significantly lower probabilities of separation. Having more dependents does not affect the probability of separation. Among both officers and enlisted personnel there exist significant occupational differences in the probability of separation. In the officer equations, the omitted occupation group is tactical operations officer. The omitted enlisted group is combat arms. For each category of personnel, the separation probability is generally highest in the omitted occupation group. This result is not surprising because these are the military-specific skills that were most in need of a reduction in force and in which the threat of involuntary separation in the event of insufficient voluntary separations was highest.

2. *Officer Separation Payment Choice Equation Estimates.*—Table 4 contains probit estimates of the linear and loglinear separation payment choice equations for officers. The negative of the coefficient on the break-even discount rate D^* (or $\ln D^*$) is equal to the inverse of the standard deviation of the unobservable factors in the equation for D (or $\ln D$). Table 4 reports the estimate of σ and its standard error.[14] In the linear model, the coefficient on D^* is negative and highly significant—the higher the break-even discount rate the lower

[14] Since $\hat{\sigma} = 1/\hat{\alpha}$, $V(\hat{\sigma}) = (\partial\hat{\sigma}/\partial\hat{\alpha})^2 V(\hat{\alpha}) = \hat{\sigma}^4 V(\hat{\alpha})$.

TABLE 4—PROBIT EQUATIONS FOR PROBABILITY OF CHOOSING SSB AND IMPLIED PDR EQUATIONS, OFFICERS

	Linear model				Loglinear model			
Variable	Parameter estimate	Standard error	ΔP	β	Parameter estimate	Standard error	ΔP	$\partial D/\partial X$
Intercept	2.3647	0.4109[a]		0.401	−0.7205	0.7311		
Male	0.0468	0.0394	0.019	0.008	0.0468	0.0394	0.020	0.009
Black	0.3731	0.0738[a]	0.149	0.063	0.3733	0.0704[a]	0.150	0.069
White	−0.0987	0.0636	−0.039	−0.017	−0.0987	0.0636	−0.039	−0.018
Number of dependents	0.1089	0.0123[a]	0.044	0.018	0.1088	0.0122[a]	0.044	0.020
Graduate education	−0.4397	0.1330[a]	−0.176	−0.075	−0.4391	0.1330[a]	−0.173	−0.080
College education	−0.1702	0.1287	−0.068	−0.029	−0.1696	0.1286	−0.067	−0.031
Wage ($10K)	−0.0057	0.0258	−0.002	−0.001	−0.0057	0.0258	−0.002	−0.001
After-tax lump sum ($10K)	−0.3253	0.1019[a]	−0.130	−0.055	−0.3280	0.1020[a]	−0.127	−0.059
Fiscal year 1992	0.4286	0.0283[a]	0.171	0.073	0.4281	0.0283[a]	0.173	0.080
Age	−0.0190	0.0055[a]	−0.008	−0.003	−0.0190	0.0055[a]	−0.008	−0.004
Years of service	0.0180	0.0456	0.007	0.003	0.0197	0.0456	0.006	0.003
South	0.0422	0.0334	0.017	0.007	0.0421	0.0334	0.017	0.008
West	0.0476	0.0372	0.019	0.008	0.0476	0.0372	0.019	0.009
Midwest	−0.0479	0.0437	−0.019	−0.008	−0.0480	0.0437	−0.019	−0.009
Army	0.0773	0.0299[b]	0.031	0.013	0.0778	0.0299[b]	0.031	0.014
Navy	0.2889	0.0733[a]	0.116	0.049	0.2875	0.0733[a]	0.119	0.055
Intelligence	0.1623	0.0501[a]	0.065	0.028	0.1624	0.0500[a]	0.065	0.030
Engineering	−0.2036	0.0368[a]	−0.081	−0.035	−0.2034	0.0368[a]	−0.082	−0.038
Scientist or professional	−0.1114	0.0693[c]	−0.045	−0.019	−0.1115	0.0693	−0.044	−0.020
Health	0.0453	0.0875	0.018	0.008	0.0455	0.0875	0.019	0.009
Administration	−0.0907	0.0457[b]	−0.036	−0.015	−0.0906	0.0457[b]	−0.037	−0.017
Support	−0.0934	0.0414[b]	−0.037	−0.016	−0.0934	0.0414[b]	−0.038	−0.017
Other	−0.2132	0.1498	−0.085	−0.036	−0.2130	0.1498	−0.084	−0.039
D^*	−5.8930	1.9223[a]						
(Sigma)	(0.1697)	(0.0554[a])						
ln D^*					−1.1770	0.3769[a]		
(Sigma)					(0.8496)	(0.2720[a])		
Rho	0.1449	0.0749[b]			0.1456	0.0748[b]		
Bivariate probit sample size	59,208				59,208			
Bivariate probit log-likelihood	−32,774.40				−32,774.21			

[a] Significant at the 0.01 level.
[b] Significant at the 0.05 level.
[c] Significant at the 0.10 level.

the probability of selecting the lump-sum payment. In the linear model the estimated value of σ is 0.1697, about double the tax-adjusted estimate reported in Table 3.[15] The coefficient on ln D^* is also highly significant in the loglinear models. Both estimates indicate that as the break-even discount rate increased, fewer personnel chose the lump sum.

The third column under each model in Table 4 shows the effect of each variable on the probability of selecting the SSB.[16] The fourth column shows the estimates of discount-rate equation parameters (linear model) or the marginal effect of each regressor on D (loglinear model). The latter is calculated at the sample mean value of $\exp\{X_i\hat{\boldsymbol{\beta}} + 0.5\hat{\sigma}^2\}$, which is each individual's predicted discount rate in the

[15] The log-likelihood function for this model, −32,774.4, was higher than for a comparable model without tax adjustment, −32,783.4.

[16] Recall that $\partial P/\partial X_i = \beta_i\phi(z)$ where $\phi(z)$ denotes the standard normal-density function evaluated at $z = X\delta - \alpha D^*$. Since, for officers, the mean SSB choice rate is very close to 0.5, z is approximately 0 at the sample means and $\phi(0)$ is 0.4.

loglinear model. For officers, the estimated effect of each regressor on the personal discount rate is quite similar between the linear and loglinear models.

Notice that the estimated correlation in the residuals between the separation and payment choice equations is about 0.145 in both models and is significant at the 0.05 level. The positive correlation suggests that those who, for unobservable reasons, were more likely to separate were also more likely to choose the lump sum. *D* will be overestimated when the separation process is ignored.[17]

Many of the demographic variables included in the separation payment choice equations are significant at conventional levels of significance and have the expected signs. Compared with other nonwhites, blacks are more likely to take the SSB; the white coefficient is negative but not significant. The implied racial difference in *D* is large—blacks are estimated to have over a 0.063 higher discount rate than other nonwhites.

The propensity to select the SSB falls with education level, with the difference most pronounced for officers with graduate educations, who are estimated to have a 0.075 lower discount rate than those officers without a college degree. Officers possessing a college degree have about a 0.03 lower rate. Army and Navy officers have a higher propensity to select the SSB compared with Air Force officers and somewhat higher implied discount rates.

[17] In fact, the essential difference between the bivariate probit estimates found in Tables 3 and 4 and simple probit estimates that ignore the selection process is in the intercept estimate of the separation payment choice equation. Consider the officer models. Simple probit estimates of the linear- and loglinear-model intercepts are 2.5509 and −0.4834 compared with bivariate probit estimates of 2.3647 and −0.7205, respectively. In the enlisted models, the simple probit estimates of the linear- and loglinear-model intercepts are 3.9566 and 0.3570, compared with the bivariate probit estimates of 3.9732 and −0.0002. Other estimates are similar in sign, magnitude, and significance in the simple and bivariate probit models. The simple probit models give larger estimates of personal discount rates than the selectivity corrected estimates (about 0.03 higher in both the officer and enlisted cases). But estimates of how discount rates vary with personal characteristics are quite similar between the two procedures. Simple probit estimates are not shown to save space, but are available upon request.

The propensity to select the SSB rises with the number of dependents, but declines with age. Each dependent adds almost 0.02 to the discount rate; each 10 years of age reduces *D* by about 0.03. That *D* increases with the number of dependents lends credence to the assumption by Becker et al. (1990) of a positive relationship.

There were significant occupational differences in the propensity to select the SSB, with tactical operations officers having a higher propensity to take the lump sum than individuals in most other occupation groups. These occupational differences may reflect differences in the transferability of human capital acquired in the military to the private sector. There were no apparent geographic or gender differences in officers' propensity to select the lump sum.

The two most significant determinants of *D* in the officer analysis are the dummy for FY 1992 and the value of the after-tax lump-sum payment. The FY 1992 dummy is positive, a result consistent with the fact that in FY 1992 other aspects of the separation choice were less generous for annuity recipients. When the disadvantages associated with the annuity choice were eliminated at the beginning of FY 1993, a significantly higher fraction of officers began choosing the annuity. The disadvantages associated with the VSI separation package added the equivalent of about 0.07 to the officer discount rate.

The probability of choosing the lump sum declines sharply with the size of the after-tax lump-sum amount. This result implies that individuals do in fact discount larger sums at a lower rate than smaller sums, with *D* estimated to decline by over 0.05 for each $10,000 increase in the lump-sum amount. This result is consistent with findings of experimental studies. However, controlling for the size of the lump-sum payment, YOS has no effect on the separation payment choice. A negative coefficient on YOS would have been consistent with hyperbolic discounting; however we find no evidence of it here.

3. *Enlisted Separation Payment Choice Equation Estimates.*—Table 5 contains the enlisted estimates. As was the case in the officer analysis, the estimated coefficients on D^* (in the linear model) and $\ln D^*$ (in the loglinear model)

TABLE 5—PROBIT EQUATIONS FOR PROBABILITY OF CHOOSING SSB AND IMPLIED PDR EQUATIONS, ENLISTED PERSONNEL

	Linear model				Loglinear model			
Variable	Parameter estimate	Standard error	ΔP	β	Parameter estimate	Standard error	ΔP	$\partial D/\partial X$
Intercept	3.9732	0.3707[a]		0.510	−0.0002	0.8938		
Male	0.0750	0.0254[a]	0.012	0.010	0.0749	0.0254[a]	0.012	0.009
Black	0.2712	0.0390[a]	0.044	0.035	0.2711	0.0390[a]	0.043	0.034
White	−0.0639	0.0367[c]	−0.010	−0.008	−0.0647	0.0367[c]	−0.012	−0.009
Number of dependents	0.0576	0.0081[a]	0.009	0.007	0.0587	0.0079[a]	0.009	0.007
Some college	−0.3766	0.0442[a]	−0.061	−0.048	−0.3769	0.0442[a]	−0.062	−0.049
High-school graduate	−0.1171	0.0307[a]	−0.019	−0.015	−0.1174	0.0307[a]	−0.020	−0.015
Mental group I	−0.1217	0.0552[b]	−0.020	−0.016	−0.1220	0.0552[b]	−0.020	−0.016
Mental group II	−0.0462	0.0216[b]	−0.008	−0.006	−0.0464	0.0216[b]	−0.008	−0.006
Mental group IIIA	0.0190	0.0221	0.003	0.002	0.0168	0.0221	0.003	0.002
Wage ($10K)	0.0058	0.0236	0.001	0.001	0.0040	0.0234	0.000	0.000
After-tax lump sum ($10K)	−0.4628	0.0683[a]	−0.075	−0.059	−0.4674	0.0681[a]	−0.075	−0.058
Fiscal year 1992	0.2385	0.0200[a]	0.039	0.031	0.2384	0.0201[a]	0.039	0.031
Age	−0.0199	0.0030[a]	−0.003	−0.003	−0.0198	0.0030[a]	−0.003	−0.003
Years of service	0.0271	0.0191	0.004	0.003	0.0271	0.0191	0.004	0.003
South	0.1261	0.0215[a]	0.021	0.016	0.1261	0.0215[a]	0.021	0.016
West	0.1042	0.0226[a]	0.017	0.013	0.1044	0.0226[a]	0.017	0.013
Midwest	0.0789	0.0326[b]	0.013	0.010	0.0803	0.0326[b]	0.013	0.010
Army	0.2383	0.0284[a]	0.039	0.031	0.2363	0.0284[a]	0.039	0.030
Navy	−0.0012	0.0267	0.000	0.000	−0.0036	0.0266	0.000	0.000
Electronics	−0.1399	0.0350[a]	−0.023	−0.018	−0.1399	0.0350[a]	−0.023	−0.018
Communication	−0.0805	0.0392[b]	−0.013	−0.010	−0.0804	0.0392[b]	−0.014	−0.011
Medical	−0.1374	0.0576[b]	−0.022	−0.018	−0.1375	0.0576[b]	−0.023	−0.018
Other technical	−0.1899	0.0540[a]	−0.031	−0.024	−0.1897	0.0540[a]	−0.031	−0.025
Administration	−0.1900	0.0308[a]	−0.031	−0.024	−0.1902	0.0308[a]	−0.032	−0.025
Electrical/mechanical equipment repair	−0.1134	0.0299[a]	−0.018	−0.015	−0.1132	0.0299[a]	−0.019	−0.015
Craftsman	−0.1555	0.0439[a]	−0.025	−0.020	−0.1556	0.0439[a]	−0.026	−0.020
Supply	−0.1067	0.0369[a]	−0.017	−0.014	−0.1068	0.0369[a]	−0.018	−0.014
D^*	−7.7853	2.4133[a]						
(Sigma)	(0.1284)	(0.0397[a])						
ln D^*					−1.5082	0.4703[a]		
(Sigma)					(0.6630)	(0.2067[a])		
Rho	0.0485	0.0251[c]			0.0486	0.0251[c]		
Bivariate probit sample size	234,952				234,952			
Bivariate probit log-likelihood	−115,039.7				−115,039.6			

[a] Significant at the 0.01 level.
[b] Significant at the 0.05 level.
[c] Significant at the 0.10 level.

are negative and highly significant. The implied estimate of σ in the linear model is 0.1284 and is indicative of less unobservable heterogeneity in personal discount rates than existed in the officer data. The estimated correlation in the residuals of the separation and payment choice equations is also lower, only 0.049.

Although enlisted personnel had a much higher average propensity to select the lump sum, the propensity to select the lump sum varies considerably with personal attributes and in the same direction as in the officer analysis. Again, blacks are estimated to be significantly more likely to take the lump sum than other nonwhites while whites are significantly less likely. Those with more education are again found to be less likely to take the lump sum and to have lower discount rates, as are older personnel. (The age coefficient is almost the same as in the linear officer model.) Although the

effect of dependents is estimated to be smaller for enlisted personnel than officers, those with more dependents are still estimated to be more likely to take the SSB and to have higher discount rates. Although there was no gender difference among officers, male enlisted personnel are more likely to take the lump sum, and have higher discount rates, than females.

The test-score effect is the most interesting new result in the enlisted analysis. Individuals in the top two mental groups are more likely than others to select the annuity and to have a lower discount rate. Higher test scores may reflect better capacity to understand or process the information about intertemporal choices. Combat arms personnel were more likely to take the SSB and have higher discount rates. Potential reasons for such a result were discussed above. As was the case in the officer models, the military wage was insignificant in both enlisted models. Significant regional differences exist in the propensity of enlisted personnel to select the SSB, whereas none were found for officers.

As in the officer results, enlisted personnel separating in FY 1992 were more likely to take the lump sum. And, the size of the lump-sum payment is again negative and highly significant. Furthermore, YOS has no influence on the separation payment choice once the size of the payment, age, and D^* are controlled for.

4. *Estimates of Personal Discount Rates from Bivariate Probit Models.*—The models reported in Tables 4 and 5, respectively, were used to calculate personal discount rates for the whole force, stayers, and leavers separately, and the whole force at each YOS. Means were obtained by using the estimated models to predict each individual's discount rate and then averaging the predictions. Table 6 provides the estimated mean rates. The FY 1992 dummy was set to 0 in these calculations to remove the effects associated with other aspects of the SSB/VSI choice. The predicted rates are nominal rates. Real discount rates would be 3–4 percentage points below the numbers in Table 6.

Several patterns emerge from Table 6. As to be expected, estimates derived from the loglinear model are higher than from the linear model and are strictly positive. The mean nominal discount rate for all officers estimated from the linear model is 0.104 while the mean estimate from the loglinear model is 0.187. The importance of controlling for sample selection is evident in the difference between the estimated mean rates for stayers and leavers. Among officers, the estimated discount-rate difference between stayers and leavers is 0.030 in the linear model and 0.028 in the loglinear model. Among enlisted personnel, the estimated difference is about 0.019 for the linear model and 0.047 for the loglinear model.

TABLE 6—MEAN NOMINAL DISCOUNT RATES

	Officers		Enlisted personnel	
	Linear model	Loglinear model	Linear model	Loglinear model
All	0.104	0.187	0.354	0.536
Stayers	0.099	0.182	0.350	0.525
Leavers	0.129	0.210	0.369	0.572
All in YOS:				
7	0.205	0.291	0.410	0.714
9	0.159	0.232	0.381	0.607
11	0.111	0.180	0.353	0.527
13	0.046	0.132	0.327	0.459
15	0	0.099	0.294	0.389

Third, D declines with YOS. Although YOS itself does not affect D, the decline reflects the combined effect of an increase in the size of the lump-sum payment and higher age. Among officers, the linear model predicts a discount rate of almost 0 by YOS 15, with the implication that a significant number of more senior officers have negative discount rates. By imposing the restriction of strictly positive discount rates, the loglinear model avoids this unfortunate prediction. However, both models fit the data equally well; we cannot distinguish between them on empirical grounds.

The very high discount rates estimated for enlisted personnel might seem to be a puzzle. But remember that enlisted personnel received lump-sum payments that were only about half of the average payment to officers (Table 1). Furthermore, enlisted personnel have lower education levels than officers and have other characteristics that would make them more prone to select the lump sum. To see how much the difference in personal attributes and the lump-sum payment difference made to the estimated difference in discount rates, we used the linear enlisted model to predict the mean en-

listed discount rate when enlisted personnel are given the same lump-sum payment as received by officers, the same average number of dependents, and the same distributions of sex, race, and education. Giving enlisted personnel the same average number of dependents and the same distribution of personal attributes reduces the mean discount rate from 0.354 to 0.288. Giving them the same lump-sum payments as officers reduces their mean discount rate to 0.22. Giving them the same lump-sum payment and the same demographic characteristics reduces their mean rate to 0.173. This mean rate is to be compared with the mean rate of 0.104 for all officers from the linear officer model. Thus, over half of the estimated mean discount-rate difference between officers and enlisted personnel is attributable to observable demographic differences and lump-sum payment differences between the two groups. Furthermore, although we do not observe the mental ability of officers, they would no doubt score better on mental tests than enlisted personnel, and we know from the enlisted results that brighter individuals have lower discount rates.

G. *Markets and Policy*

We find evidence of high personal discount rates in our sample of military separatees. Readers might remain skeptical that the rates we estimate are representative of the general population. But other anecdotal evidence points to high discount rates in subsets of the general populace. Lawrence M. Ausubel (1991) finds that over three-quarters of credit card holders do not pay their balances monthly but pay interest at rates often exceeding 18 percent on outstanding balances averaging over $1,000. Another piece of anecdotal evidence is the development of a rapidly growing market in the United States in which firms buy annuity streams from recipients of divorce and personal-injury settlements, and other forms of delayed payment. *The Wall Street Journal* reports that between 1995 and 1998, J. G. Wentworth and Company, the largest firm in this market, acquired the rights from over 7,000 people to over $250 million in deferred payments.[18] The average discount rate on these purchases was 21 percent. Individuals selling their deferred streams to Wentworth and other such firms tended to be persons with claims to relatively small annual payments and small incomes from other sources.[19]

Clearly, the drawdown program's lump-sum alternative to annuity payments was welfare enhancing and saved the federal government (and taxpayers) money. The fact that individuals chose the lump-sum alternative in spite of DoD's attempts to discourage them from doing so indicates that they viewed themselves as better off with that choice. The lump-sum alternative saved the federal government a substantial amount. Using the 7-percent discount rate on government bonds prevailing at the time of the program, we calculate that if only the annuity alternative had been available, the present value of the annuity payments would have been $4.2 billion. The present value of the actual annuity payments plus lump-sum payout was $2.5 billion. The lump-sum alternative thus saved the federal government $1.7 billion.

IV. Conclusions

The size of the personal discount rate has been the subject of numerous studies. But past studies have not been entirely convincing because estimates have for the most part been based on hypothetical choices or choices involving relatively small sums, or were inferred from other behavior. What makes this study interesting, and we think more convincing, are the data: the military drawdown with its accompanying separation programs has provided a large-scale natural experiment involving large numbers of individuals making choices over substantial sums of money, individuals whose earnings, education levels, and other attributes are representative of the wide spectrum of American society. We find significant demographic variation in discount rates in directions suggested by theory and by recent experimental work. We find relatively high discount rates among military personnel, especially the enlisted

[18] *The Wall Street Journal* (February 25, 1998).

[19] Another firm buying such income streams, the Peachtree Settlement Company of Atlanta, GA, advertises almost nightly on the Prevue cable channel. It explicitly tells viewers to convert their *small* claims into one *large* lump-sum payment.

personnel. But we also find discount rates to vary inversely with the size of the lump-sum payment such that individuals place low discount rates on large sums. Our estimates are similar to discount rates in the rapidly developing market for purchases of deferred income streams.

Finally, it is useful to mention that, like the military, large corporations downsizing in the early 1990's also offered separatees the opportunity to take lump-sum buyouts of their accumulated pension benefits. While systematic data on the terms of the buyouts and the implied break-even discount rates are not available, one anecdotal report indicates that a high percentage of private-sector separatees is selecting lump-sum buyouts in lieu of deferred annuities.[20] When they become available, analysis of private-sector data will be another interesting avenue of future research on personal discount rates.

[20] See *The Wall Street Journal* (July 31, 1995).

APPENDIX A

TABLE A1—SAMPLE MEANS

Variable	Officer	Enlisted
Male	0.855	0.887
White	0.863	0.656
Black	0.105	0.295
Wage	$43,901	$21,563
After-tax lump sum	$42,091	$23,507
Graduate education	0.417	
College degree	0.573	
Some college		0.094
High-school graduate		0.844
Dependents	3.04	3.12
Age	33.9	30.9
YOS	10.9	11.0
ATETS	0.952	0.417
Mental group I		0.024
Mental group II		0.296
Mental group IIIA		0.238
Tactical operations	0.447	
Intelligence	0.067	
Engineering	0.169	
Science	0.065	
Health	0.029	
Administration	0.099	
Support	0.110	
Other	0.014	
Combat arms		0.140
Electronics		0.126
Communication		0.071
Medical		0.023
Other technical		0.032
Administration		0.219
Electrical/mechanical equipment repair		0.266
Craftsman		0.044
Supply		0.079

APPENDIX B

TABLE B1—PROBIT EQUATION FOR PROBABILITY OF OFFICER SEPARATION (BASED ON LINEAR MODEL)

	Army		Navy		Air Force	
Variable	Parameter estimate	Standard error	Parameter estimate	Standard error	Parameter estimate	Standard error
Black	0.040	0.048	0.050	0.174	−0.150	0.058[b]
White	−0.115	0.044[a]	0.126	0.148	−0.119	0.058[b]
Male	−0.274	0.030[a]	−0.126	0.097	−0.105	0.032[a]
College graduate	0.139	0.097	−0.282	0.094[a]	−0.046	0.227
Graduate education	−0.040	0.099	−0.405	0.099[a]	−0.520	0.227[b]
Dependents	0.006	0.006	−0.035	0.018[b]	−0.011	0.007
Wage	0.105	0.0181[b]	−0.186	0.049[a]	−0.048	0.020[b]
O-3, YOS 7–8	−1.954	0.314[a]	−0.143	0.328	−0.049	0.250
O-3, YOS 9–10	−1.683	0.315[a]	−0.396	0.336	−0.188	0.252
O-3, YOS 11–12	−1.740	0.317[a]	−0.637	0.354	−0.089	0.254
O-3, YOS 13–15	−1.813	0.318[a]	−0.696	0.356[b]	−0.244	0.256
O-4, YOS 7–8	−2.021	0.413[a]	−0.989	0.514[c]		
O-4, YOS 9–10	−2.349	0.354[a]	−1.297	0.427[a]	−0.935	0.387[b]
O-4, YOS 11–12	−2.540	0.322[a]	−0.945	0.357[a]	−0.786	0.263[a]
O-4, YOS 13–15	−2.360	0.319[a]	−0.972	0.369[a]	−0.815	0.260[a]
Intelligence	−0.083	0.033[b]	−0.043	0.141	0.227	0.045[a]
Engineering	0.008	0.029	−0.526	0.096[a]	0.152	0.029[a]
Science	−0.467	0.051[a]	−0.330	0.129[b]	0.100	0.043[b]
Health	−0.405	0.046[a]			0.370	0.010[a]
Administration	−0.088	0.033[a]	−0.216	0.104[b]	0.255	0.038[a]
Support	−0.008	0.028	−0.225	0.084[a]	0.159	0.038[a]
Other	−0.358	0.068[a]	−0.558	0.151[a]	−0.445	0.465
South	0.002	0.021	0.322	0.061[a]	0.040	0.033
Midwest	−0.062	0.032[b]	0.561	0.144[a]	0.012	0.036
West	−0.011	0.027	0.028	0.063	0.058	0.032[c]
At end of term of service	1.106	0.289[a]	0.171	0.189	−0.032	0.033

[a] Significant at the 0.01 level.
[b] Significant at the 0.05 level.
[c] Significant at the 0.10 level.

TABLE B2—PROBIT EQUATION FOR PROBABILITY OF ENLISTED SEPARATION (BASED ON LINEAR MODEL)

	Army		Navy		Air Force	
Variable	Parameter estimate	Standard error	Parameter estimate	Standard error	Parameter estimate	Standard error
Black	0.157	0.014[a]	0.157	0.014[a]	0.157	0.014[a]
White	0.358	0.013[a]	0.358	0.013[a]	0.358	0.013[a]
Male	−0.057	0.010[a]	−0.057	0.010[a]	−0.057	0.010[a]
Some college education	−0.178	0.017[a]	−0.178	0.017[a]	−0.178	0.017[a]
High-school graduate	−0.067	0.012[a]	−0.067	0.012[a]	−0.067	0.012[a]
Mental group I	0.052	0.022[b]	0.052	0.022[b]	0.052	0.022[b]
Mental group II	0.053	0.008[a]	0.053	0.008[a]	0.053	0.008[a]
Mental group IIIA	0.053	0.008[a]	0.053	0.008[a]	0.053	0.008[a]
Dependents	0.024	0.002[a]	0.024	0.002[a]	0.024	0.002[a]
Wage	0.478	0.013[a]	−0.219	0.023[a]	0.021	0.013
E-4, YOS 7–8			0.595	0.200[a]	−1.524	0.036[a]
E-4, YOS 9–10	−0.060	0.035	−0.273	0.161	−0.089	0.039[b]
E-4, YOS 11–12	0.119	0.074	−0.297	0.325	−0.078	0.104
E-4, YOS 13–15	−0.159	0.136	−0.306	0.423	−0.188	0.163
E-5, YOS 7–8	−3.073	0.035[a]	0.584	0.059[a]	−1.641	0.036[a]
E-5, YOS 9–10	−1.651	0.030[a]	−0.428	0.055[b]	−0.984	0.036[a]

TABLE B2—*Continued*

Variable	Army		Navy		Air Force	
	Parameter estimate	Standard error	Parameter estimate	Standard error	Parameter estimate	Standard error
E-5, YOS 11–12	−0.989	0.031[a]	−0.581	0.057[a]	−1.005	0.038[a]
E-5, YOS 13–15	−0.970	0.032[a]	−0.544	0.060[a]	−1.093	0.038[a]
E-6, YOS 7–8	−3.651	0.068[a]	0.597	0.069[a]	−2.036	0.210[a]
E-6, YOS 9–10	−2.526	0.035[a]	−0.420	0.060[a]	−1.895	0.063[a]
E-6, YOS 11–12	−2.335	0.034[a]	−0.603	0.061[a]	−2.055	0.047[a]
E-6, YOS 13–15	−2.319	0.033[a]	−0.671	0.062[a]	−2.108	0.042[a]
E-7, YOS 7–8	−2.522	0.426[a]				
E-7, YOS 9–10	−2.851	0.131[a]				
E-7, YOS 11–12	−2.822	0.064[a]	0.791	0.146[a]	−2.222	0.110[a]
E-7, YOS 13–15	−2.385	0.038[a]	1.351	0.108[a]	−2.385	0.057[a]
Electronics	−0.122	0.013[a]	−0.122	0.013[a]	−0.122	0.013[a]
Communication	−0.065	0.015[a]	−0.065	0.015[a]	−0.065	0.015[a]
Medical	−0.203	0.022[a]	−0.203	0.022[a]	−0.203	0.022[a]
Other technical	−0.157	0.020[a]	−0.157	0.020[a]	−0.157	0.020[a]
Administration	0.002	0.011	0.002	0.011	0.002	0.011
Electrical/mechanical equipment repair	−0.107	0.109[a]	−0.107	0.109[a]	−0.107	0.109[a]
Craftsman	0.103	0.017[a]	0.103	0.017[a]	0.103	0.017[a]
Supply	0.141	0.014[a]	0.141	0.014[a]	0.141	0.014[a]
South	0.040	0.008[b]	0.040	0.008[b]	0.040	0.008[b]
Midwest	0.127	0.026[a]	0.127	0.026[a]	0.127	0.026[a]
West	0.082	0.017[a]	0.082	0.017[a]	0.082	0.017[a]
At end of term of service	0.280	0.012[a]	−0.050	0.015	0.184	0.009[a]

[a] Significant at the 0.01 level.
[b] Significant at the 0.05 level.
[c] Significant at the 0.10 level.

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