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ALTERNATIVE MILITARY RETIREMENT SYSTEMS: THEIR EFFECTS ON ENLISTED RETENTION

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The virtues and criticisms of the current military retirement system are described. Then an economic model is developed for analyzing the effects of different retirement systems on retention. The model also can be used to analyze other kinds of changes to the military compensation system. Here it is used to estimate the effects of three retirement plans on enlisted retention and force structure: (1) a two-tier plan that reduces annuities after 20 years of service, (2) a trust fund plan recommended by

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20. the President's Commission on Military Compensation that provides some benefits after 10 years but fewer after 20 years, and (3) a two-tier plan recommended by the Secretary of Defense that allows early withdrawal of prospective 20-year benefits after 10 years of service.

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2. This Research Contribution describes the development and application of a career force retention model. The model was used to estimate the effects on enlisted retention in all four services of three different military retirement plans. One plan simply reduces annuities after 20 years of service. Another is a trust fund plan recommended by the President's Commission on Military Compensation. The third is an early withdrawal plan recently submitted to Congress by the Department of Defense.

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TABLE OF CONTENTS

	Page
Acknowledgements	iii
Introduction and summary	1
An economic model of retention behavior	7
Calculating the retention incentive under alternative retirement systems	7
Relating the annualized cost of leaving to retention	10
Determination of the slope parameter β in the reenlistment supply equation	15
Analysis of three military retirement plans	22
The plans	22
The retention analysis	27
Retention patterns under the current system	27
Choice of a discount rate	29
Values of the annualized cost of leaving for alternative retirement systems	30
The retention estimates	32
Evaluation	42
References	44
Appendix A: FY 1977 retention statistics	A-1 - A-4
Appendix B: Retention predictions by service	B-1 - B-13

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INTRODUCTION AND SUMMARY

The current military retirement system is a 20-year retirement system. It offers an immediate annuity of 50 percent of basic pay to those who retire after 20 years of service, but nothing to those who leave before then. Retired pay is a key element of military compensation, and the retirement system in general plays a central role in the services' personnel management systems. That retired pay is a key element of compensation is seen from its accrual costs. These costs, the yearly amount of money that would need to be set aside to fully fund future retirement liabilities of those now on active duty, are about 37 percent of yearly base pay outlays.

The retirement system plays a central role in personnel management in several ways. Because future retired pay is implicitly a large component of the compensation of personnel with between 10 and 20 years of service, the retirement system promotes very high retention among these personnel. Yet, once personnel become eligible for an immediate annuity upon completing 20 years, retention drops sharply. Not all of this drop is voluntary; after 20 years the services do separate involuntarily personnel who have failed promotion. Because of the high voluntary turnover it generates after 20 years, coupled with the services' ability to separate those who have failed promotion, the current retirement system helps sustain the up-or-out promotion system and fairly rapid promotions for younger personnel. The services generally support the current retirement system both because it ensures a stable supply of experienced personnel and because it supports the up-or-out promotion system.

Despite these perceived virtues, the current system has come under increasing criticism in recent years, primarily for its cost. In the past decade, five commissions or study groups have recommended changes to the system. The most recent, and most radical, proposal for change was put forth by the President's Commission on Military Compensation (PCMC), a commission established in 1977 by President Carter.[1] While the primary objection the PCMC had to the current system was its cost, it was criticized on other grounds (reference 1). Among them, the current system does not provide very strong retention incentives for either very young personnel or personnel

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[1] Prior to the PCMC, the previous commissions or study groups recommending changes to the military retirement system include the First Quadrennial Review of Military Compensation (1967), the Interagency Committee, known as IAC (1971), a Department of Defense study group that proposed the Retirement Modernization Act, or RMA (1974), and the Defense Manpower Commission (1976).

over 20 years who the services would like to keep. Implicitly, the PCMC felt -- and some military manpower analysts also think -- that a military force that has fewer first-term personnel, more second-term personnel, and (possibly) fewer personnel over 10 years would be more productive, as well as cheaper, than today's force.[1] The PCMC recommended a retirement system that it felt would move the military force structure in this direction.

In evaluating alternative retirement plans, it is important to estimate quantitatively the impact these plans would have on personnel retention patterns and the average experience level and distribution of the armed forces. Estimates are required both to determine whether a particular retirement plan will by itself be able to sustain an adequate military force and to determine how much active duty pay (e.g., bonuses) would have to be increased in the event that the plan by itself will not sustain an adequate force. Also important to evaluate is the impact a new system would have on yearly accession requirements, a critical concern in coming years.

After the PCMC issued its final report, its proposals were reviewed by the Office of the Assistant Secretary of Defense for Manpower, Reserve Affairs, and Logistics (OASD(MRA&L)). As part of its review, OASD(MRA&L) tasked CNA to analyze the impact the PCMC proposal and various other plans under consideration would have on retention patterns.[2] This report contains the results of these analyses, including an analysis of the plan finally selected by the Secretary of Defense.

This report is organized into two major sections. The first section develops an economic model of retention behavior. It should be emphasized that this model is a general model which can be used to analyze all types of changes to the military compensation system, not just retirement changes. The second section analyzes three alternatives to the current system -- the PCMC plan, the plan finally selected by OSD, and an RMA-type plan.

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[1] Obviously, this is a general statement. In some career fields today's force structure may be more productive than an alternative one. The PCMC recommended a more flexible pay system so that each career field could be managed separately rather than constraining various career fields to the roughly same experience distribution.

[2] CNA had previously performed an analysis of the PCMC proposal (reference 2).

Results for other plans which were analyzed during OSD's evaluation of the PCMC proposal are available from the author. While these latter plans may be considered "dead" at this point, they probably represent the range of feasible alternatives to the current military retirement system. Empirical estimates of retention for these plans will thus prove useful when the Congressional debate on military retirement begins.

The model employed in the retention analysis is a variant of the cost of leaving model first proposed by Gotz and McCall (reference 3). This model is called the Annualized Cost of Leaving, or ACOL, model. In this model individuals compare (the present value of) the financial cost of leaving over each possible future time horizon of military service with the present value of their yearly taste for service factors over the horizon. Over each possible future horizon, the financial cost of leaving is the present value of the active duty military pay plus the increment in the present value of retired pay minus the present value of the civilian earnings forgone. Individuals stay only if there exists at least one future time horizon of military service over which the present value of the cost of leaving exceeds (the negative of) the present value of their yearly taste for service. This condition for staying can be restated to say that individuals stay only if there exists at least one future horizon over which the annualized cost of leaving exceeds the negative of their yearly taste for service factor.

This model was implemented empirically by estimating the relationship between annualized cost of leaving and retention rates using data from the current compensation system. The fitted relationship was then used to forecast retention under each alternative retirement system. Details of this methodology are found in the text.

Three types of retirement plans were considered by OASD(MRA&L). First there were two-tier plans similar to the earlier RMA and IAC plans. These plans must be regarded as simple "cut the cost" plans. They maintain the 20-year retirement system, but at reduced annuity levels. They provide a first-tier annuity immediately upon retirement that is lower than the current system annuity, and a second-tier annuity roughly comparable to the current system annuity during "old age." While individuals would become vested in the old age annuity after 10 years of service, its value to active duty personnel is rather low.

The retention analysis gave the obvious result that these plans would lead to lower retention prior to 20 years of service. In the absence of any other policy changes, these plans would lower the average experience of the force, and more accessions would be required to maintain today's force levels. In the two-tier plan evaluated here, the all-DoD career force is predicted to decline by between 29,000 and 45,000. Yearly accession requirements are predicted to rise by between 11,000 and 17,000.

These considerations lead to the development of two-tier plans with "early withdrawal" options and trust-fund plans like the PCMC plan. These two types of plans are similar in that they both provide cash payments to individuals who complete 10 years of service. The intent of these cash payments is to provide increased retention incentives for young personnel and increase the number who complete ten years. The institution of a retirement system with "up front" cash benefits such as these plans provide is seen as a prerequisite for making changes to the military force structure that many analysts believe are desirable.[1]

Under the two-tier plans with an early withdrawal option, individuals are vested in some fraction of their prospective first-tier annuity upon completing ten years of service. They can cash in their vested portion upon leaving or while remaining on active duty. Individuals who cash in their vested amounts will have their first-tier annuities reduced if they reach 20 years of service. Because of the availability of an immediate annuity upon completion of 20 years, the early withdrawal plans still maintain 20-year retirement as a significant retention incentive and management tool.

The trust fund plans eliminate the importance of 20-year retirement entirely. These plans would provide a trust fund and an old age annuity to individuals who complete ten years of service. The fund would be financed by annual contributions from DoD. The primary purpose of the fund -- at least the primary purpose stated by the PCMC -- is to aid the individual's transition from military back to civilian life. However, after completing ten years of service, individuals would be allowed to withdraw some fraction of their fund each year while remaining on active duty. Since in all trust fund plans considered the value of the fund grows rather smoothly after individuals become vested, the importance of 20-year retirement is eliminated.

The retirement plan finally selected by OSD is a two-tier early withdrawal plan. This plan would allow an individual to withdraw a total of 20 months' base pay between his 10th and 15th years of service. The withdrawals allowed under this plan are lower than the withdrawals allowed in other plans considered in this report and lower than the trust fund provided by the PCMC plan. The available withdrawals were lowered in order to reduce the transition costs of the plan. For individuals who make no withdrawals, the first-tier annuity is about 25 percent lower than the annuity

[1]Such changes could of course also be obtained within the framework of a less generous two-tier retirement system by increased bonuses for younger personnel.

offered by the current system. The second-tier annuity is almost the same as today's.

The retention analysis indicated that both the early withdrawal and trust fund plans would lead to increased retention before ten years of service. The estimated range of increases is from about 16 percent for the OSD plan to about 25 percent for other more generous plans. The PCMC plan is predicted to increase retention prior to ten years of service by about 20 percent. Both types of plans would have less retention than the current system between the 10th and 20th years of service. A 30 to 35 percent decline in retention is predicted for the OSD plan. The largest drop, between 42 and 53 percent, is predicted for the PCMC plan. All of the plans would lead to higher retention after 20 years of service, with it increasing most dramatically under the PCMC plan (the reason for this is discussed in the text).

Overall, the retention analysis indicates that the OSD plan would support about the number of careerists and the same yearly accessions as the current system. (Under some assumptions, careerists increase slightly and yearly accessions decline slightly; under other assumptions the reverse occurs.) However, the distribution of the career force would change fairly significantly. The OSD plan is estimated to (1) increase the number with 5-10 years of service by between 14,000 and 18,000, (2) reduce the number with 11-20 years of service by between 29,000 and 40,000, and (3) increase the number with more than 20 years by between 9,000 and 13,000.[1] These changes represent about a 4 percent increase in 5-10 year personnel, a 10 percent reduction in 11-20 year personnel, and a 22 percent increase in post-20 year personnel.

The most significant force structure changes would occur under the PCMC plan. The number of careerists is predicted to increase while yearly accessions decline. These changes occur primarily because of the very large increase in post-20 year retention predicted for this plan. The number of careerists with more than 20 years of service is predicted to rise by between 20,000 and 24,000 -- an increase of between 38 and 46 percent. The number of careerists with between 5 and 10 years of service is predicted to rise by between 22,000 and 29,000, about 8,000 to 11,000 more than predicted for the OSD plan. However, the decline in the number of careerists with 11-20 years of service is 5,000 to 7,000 more than for the OSD plan.

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[1] These force profile changes are obtained from cases 2 and 5 in table 15 below.

We end this summary with a plea for caution in the interpretation and use of the results presented in this report. Many uncertainties about the response of personnel to pay changes remain. Most important, the pay elasticities estimated herein and applied to the prediction of changes in retention are based upon very few observations, and therefore should be viewed with skepticism until confirmed (or modified) by more empirical analysis. In addition, the possibility exists that personnel will view any change to the retirement system as an erosion of benefits and react negatively to it. If this happens, the retention changes predicted for plans that restructure retirement benefits rather than simply reducing them may not occur. All in all, the retention changes predicted for different retirement plans should be viewed as rough order-of-magnitude changes.

AN ECONOMIC MODEL OF RETENTION BEHAVIOR

This section develops an economic model of retention behavior. The model is divided into two parts. The first part calculates the annualized cost of leaving military service under alternative compensation systems. The second part is a supply equation relating the annualized cost of leaving to the reenlistment rate.

CALCULATING THE RETENTION INCENTIVE UNDER ALTERNATIVE RETIREMENT SYSTEMS

For an individual in the t^{th} year of service (YOS), our first objective is to determine how the incentive to remain in service will change with a change in the compensation system. To begin, let M_j be the individual's expected active duty pay in each future YOS, R_t be the present value of retired pay the individual will receive if he leaves at YOS t, and R_n be the present value at YOS n of retired pay he will receive if he stays until YOS n (where $n > t$). Further, let W_t be the present value of the civilian income stream the individual expects to receive if he leaves now and W_n be the present value at YOS n of the civilian income stream he expects to receive if he waits until YOS to leave. Finally, let δ be the individual's yearly "taste for service" factor. δ is the monetary value the individual places on the nonpecuniary aspects of military versus civilian life. It may be thought of as the yearly differential between civilian and military pay that is necessary to make him indifferent between civilian and military life. A positive value of δ means that the individual prefers the nonpecuniary aspects of military life to the nonpecuniary aspects of civilian life, while a negative value of means that the individual prefers the nonpecuniary aspects of civilian life.

Given these definitions, the cost of leaving at YOS t rather than some future year n, $C_{t,n}$, is given by equation (1):

$$C_{t,n} = \sum_{j=t}^{n} \delta d^{j-t} + \sum_{j=t}^{n} M_j d^{j-t} + (R_n+W_n)d^{n-t} - R_t - W_t \qquad (1)$$

In equation (1), d is equal to $\frac{1}{1+\rho}$ where ρ is the individual's yearly rate of time preference, or discount rate. If the individual has to leave at YOS 30, there are 30-t costs of leaving for him to consider. Note that $C_{t,n}$ is composed of two parts. The term $\sum_{j=t}^{n} \delta d^{j-t}$ represents the non-precuniary return from staying in service from YOS t to YOS n, while the term $\sum_{j=t}^{n} M_j d^{j-t} + (R_n+W_n)d^{n-1}-R_t-W_t$ represents the change in financial wealth due to staying from YOS t to YOS n. This latter term is the financial cost of leaving at YOS t rather than remaining until YOS n.

Will the individual stay or leave at YOS t? We presume that he will stay only if there exists at least one future horizon of military service over which $C_{t,n}$ is positive. If $C_{t,n}$ is negative over all possible future horizons, he will leave. This condition for staying can be rewritten to say that he will stay only if there exists some future YOS such that

$$-\delta \sum_{j=t}^{n} d^{j-t} < \sum_{j=t}^{n} M_j d^{j-t} + (R_n+W_n)d^{n-t}-R_t-W_t.$$

Thus, the individual will stay only if there exists at least one future horizon over which the financial cost of leaving exceeds the negative of the non-pecuniary returns from staying. If δ is negative (the individual prefers the non-pecuniary aspects of civilian life to the non-pecuniary aspects of military life), the term, $-\delta \sum_{j=t}^{n} d^{j-t}$ will be positive. The financial cost of

$-\delta \sum_{j=t}^{n} d^{j-t}$, before he will stay. Note that some individuals -- those with large enough positive values of δ -- will remain in the military even if the financial cost of leaving is negative.

Now, the condition for staying can be rewritten one more time. The individual will stay only if there exists at least one future horizon over which

$$-\delta < \left(\sum_{j=t}^{n} M_j d^{j-t} + (W_n+R_n)d^{n-t} - R_t - W_t\right) \div \sum_{j=t}^{n} d^{j-t}.$$

The term on the right hand side of this inequality is the financial cost of leaving annuitized over the interval from YOS t to YOS n. We will call this the annualized cost of leaving, or $A_{t,n}$. That is, $A_{t,n}$ is a constant annual amount over the interval from YOS t to YOS n that has the present value $C_{t,n}$ at YOS t. $A_{t,n}$ is equivalent to the "perceived" annual military- civilian pay differential for an individual who remains in service from YOS t to YOS n. We say perceived because $A_{t,n}$ depends on the individual's discount rate. For instance, under today's compensation system, where much of the compensation is in the form of future retirement benefits, individuals who have high discount rates will "perceive" a lower pay differential than individuals who have lower discount rates. This condition for staying has a nice interpretation. Since $-\delta$ represents the individual's yearly distaste for service, he will stay only if there exists at least one future time horizon over which the perceived annual pay differential, $A_{t,n}$, exceeds his yearly distaste for service. If there exists no future horizon over which $A_{t,n}$ exceeds $-\delta$, he will leave.

Now for an individual at YOS t, there are 30-t values of $A_{t,n}$ to consider. To decide whether to stay or leave, the individual must compare each possible value of $A_{t,n}$ to his $-\delta$. If any values of $A_{t,n}$ exceed $-\delta$, obviously the maximum does. Therefore, the relevant value of $A_{t,n}$ in the individual's decision calculus is the maximum value in the set $\{A_{t,t+1}; A_{t,t+2} \ldots ; A_{t,t+30}\}$. We will label this maximum value A_t. If δ takes on a larger negative value than $-A_t$ there will be no future horizon of military service over which $C_{t,n}$ in equation (1) is positive. In this case the individual will leave the service.

We call this model the Annualized Cost of Leaving, or ACOL, Model. In previous drafts of this report, and in discussions with other people working on the retirement problem, there has been some confusion about the similarity or difference between this model and models, such as the original dynamic programming model of Gotz and McCall (reference 3). In previous drafts of this report, we referred to the original Gotz-McCall model as the PVCOL (present value of cost of leaving) model. This model works backwards rather than forwards. Starting at YOS 30 it computes optimum returns and costs of leaving recursively. Implicitly, it calculates the cost of leaving C_t as the maximum of $\{C_{t,t+1}; C_{t,t+2} \ldots C_{t,30}\}$. The original dynamic programming model did not have a taste factor in it. Therefore values of C_t calculated from it are costs of leaving only for someone with neutral tastes for service. The model had no mechanism in it for explaining the retention decision.

Consider, however, a dynamic programming model with tastes imbedded in it. Let $C_t(\delta)$ be the maximum cost of leaving, where $C_t(\delta)$ includes the present value of the taste factor δ over the "optimal" time horizon.[1] Again, the individual is presumed to stay only if $C_t(\delta) > 0$. But the smallest value of δ that will still make $C_t(\delta)$ positive is $-A_t$, where A_t is again the maximum of $\{A_{t,t+1}; \ldots A_{t,30}\}$. If δ is more negative than $-A_t$, the individual will leave. If δ is more positive, he will stay. It is now clear that the ACOL model is really a PVCOL model with a taste factor included.[2] The ACOL model is essentially a closed form solution for the δ that separates stayers from leavers at each YOS.

In the analysis below, the annualized cost of leaving is subscripted by paygrade (i) as well as length of service (t). For each paygrade and year of service combination, expected future military pay streams and retired pay are calculated using actual promotion data from FY 1977.

RELATING THE ANNUALIZED COST OF LEAVING TO RETENTION

The previous section developed an economic model of the retention decision. We now need to specify empirically the relationship between the incentive to stay, as measured by A_{it}, and the retention, or reenlistment rate at YOS t. We ultimately want to rate at YOS t. We ultimately want to determine how <u>continuation</u> rates will be affected by a change in A_{it}, so the distinction between continuation and reenlistment rates should be made. The continuation rate at YOS t is the fraction of personnel beginning YOS t who complete YOS t. The reenlistment rate at YOS t is the fraction of personnel reaching ETS (Expiration of Time in Service) in YOS t who reenlist. In the case of enlisted personnel, enlistment contracts are usually for more than one year, so only a frac-

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[1]The optimal time horizon is the length of military service that maximizes the present value of the future income stream, where "income" now includes the present value of δ over this optimal future length of military service.

[2]I am indebted to Glenn Gotz for useful discussions which enabled me to see the equivalence of these models.

tion of the personnel at YOS t make reenlistment decisions. The reenlistment rate is typically much lower than the continuation rate.

The continuation rate in paygrade i at YOS t is equal to

$$C_{it} = f_{it}r_{it} + (1-f_{it})n_{it} \qquad (2)$$

where: C_{it} = continuation rate

r_{it} = reenlistment rate

f_{it} = fraction of cohort making a reenlistment decision

n_{it} = continuation rate of those not at ETS.

The reenlistment rate reflects the voluntary supply behavior of those who are eligible to make a stay-leave decision, while the non-ETS continuation rate represents involuntary continuation behavior.[1] Therefore, in the analysis below, we assume that a change in A_{it} will affect the reenlistment rate, r_{it}, but not the continuation rate of those not at ETS, n_{it}.

A difficulty in determining how a new retirement system will affect continuation rates is knowing how the yearly fractions at reenlistment f_{it} will change. Two types of change from the current system would probably occur. First, f_{it} tends to be low under the current system between 10 and 20 years of service as individual sign long contracts to be assured of reaching 20 years. Second, under the current system, fairly large fractions reach ETS in the 8th and 9th years of service. Under a system that has vesting at the 10th year, these fractions might be lower in the 8th and 9th years (and the 10th year fraction consequently higher), as personnel sign

[1]An exception to this statement is after YOS 20. After 20 years the services now allow individuals who have not reached ETS to retire. The difference between r_{it} and n_{it} is much smaller after YOS 20 than before.

contracts that enable them to complete 10 years of service. Generally speaking, the reenlistment pattern will be expected to change as personnel "game the system" to their maximum advantage. Personnel clearly game the system today -- witness the large fractions reaching the end of their enlistment contracts at the 20th year of service. Changes in the pattern of enlistments may have an important effect on continuation rates even if reenlistment rates themselves do not change.

The services participated in providing judgements on how reenlistment patterns would change under each new system. These judgements were based both upon how incentives are changed by each new system, and upon how the services would attempt to management reenlistment contracts under a new system. While these judgements are not based on any formal model, there is no better way at the present time of determining how the pattern of reenlistments would change. The reenlistment patterns assumed for the different plans are discussed in more detail in the empirical analysis.

Now we will specify the relationship between the reenlistment rate r_{it} and A_{it}. First note that the model as it stands has a problem. To see the problem, let A_{i1} be the annualized cost of leaving at the first term reenlistment point, and suppose that δ is normally distributed among those facing a first-term reenlistment decision. If those for whom $A_{i1} > -\delta$ stay and those for whom $A_{i1} < -\delta$ leave, this taste distribution is truncated at the point A_{i1}. The distribution of δ among those reaching the second-term reenlistment point would be a truncated normal whose lowest value is A_{i1}. This implies that if A_{i2} exceeds A_{i1}, the retention rate at the second term will be unity. Under today's system, retention rates are nowhere near unity at the second, or even third, reenlistment points, even though A_{it} is observed to rise with YOS. The model of the retention decision needs to be modified.

One way to do this is to suppose that random, unanticipated factors as well as fixed taste factors affect the retention decision at each reenlistment point. These unanticipated factors serve to reformulate the taste distribution at each reenlistment decision point. Examples of unanticipated factors include an unusually "bad" or "good" assignment, a good civilian job offer, or getting married.

Let ϵ_t represent a value of the transitory factor at YOS t. We will assume that ϵ_t is distributed normally with mean zero and standard deviation σ_ϵ. With the introduction of the transitory component ϵ_t, the retention decision becomes to stay if $-(\epsilon_t + \delta) < A_{it}$) or leave if $-\epsilon_t < A_{it} + \delta$. The reenlistment rate is the proportion of individuals for whom $-\epsilon_t > A_{it} + \delta$. The model implies a rising reenlistment rate as t increases (as long as A_{it} does not decline), since the average value of δ among those at YOS t will rise as t increases. Yet, it avoids the implication that reenlistment rates will rise to unity after the first-term reenlistment point. At the first-term decision point -- as well as later decision points -- the taste distribution is not truncated, only "thinned out" in the lower tail. At each point, some individuals with negative values of δ will be induced to stay if they "draw" large enough positive values of ϵ.

Now we specify the reenlistment equation mathematically. On the assumption that ϵ_t is distributed normally, r_{it} can be expressed as a logistic function of A_{it}[1]:

$$r = \frac{1}{1+e^{-\left(\alpha_{it} + \beta A_{it}\right)}} \qquad (3)$$

The constant term α_{it} differs from one YOS to the next. We expect that $\alpha_{it'} > \alpha_{it}$ for $t' > t$. This rising constant term captures the rising mean of the taste distribution as YOS increases. For instance, if A_{it} were 0 for all i and t, the rise in r_{it} as t increases would be due strictly to the disproportionately greater losses in earlier YOS cells of those with large negative values of δ.

Figure 1 illustrates the logistic relationship between r_{it} and A_{it} for two different YOS groups. The relationship between A_{it} and r_{it} is S-shaped rather than linear. This specification of the relationship has two desirable properties. First, since the logistic function is a probability function, r_{it} is bounded by 0 and 1, as it should be. A linear function does not guarantee such bounds. Second, the effect of a change in A_{it} on r_{it} diminishes as r_{it} approaches one or zero. If A_{it} and hence r_{it} are already very

[1] The logistic distribution is a convenient closed form approximation to a standard normal distribution. It has been used in many previous studies of retention (see references 4 and 5).

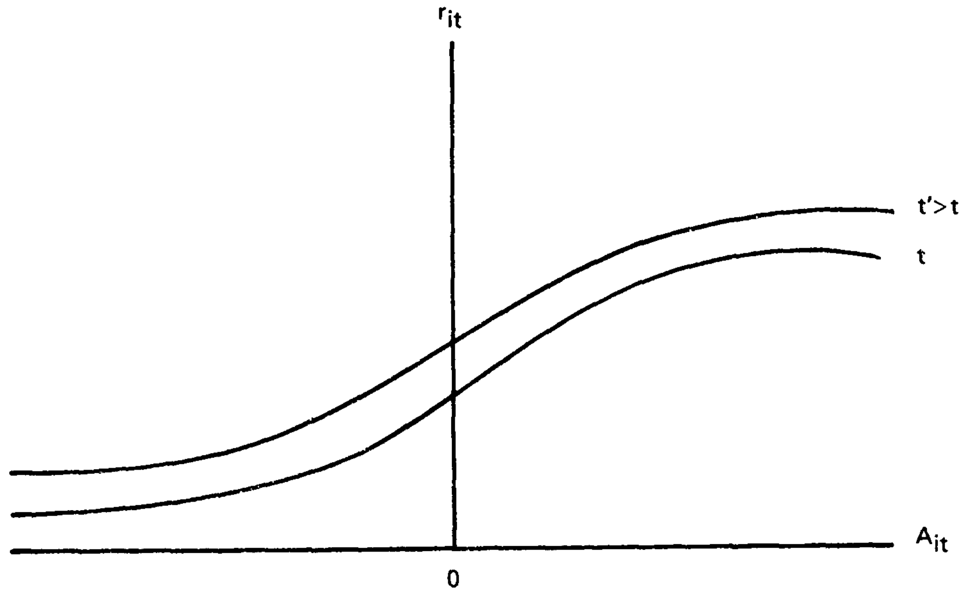

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FIG. 1: LOGISTIC RELATIONSHIP BETWEEN A_{it} AND r_{it}

high (or very low), small changes in A_{it} will not have much effect on r_{it}. Small changes in A_{it} will have their greatest effect as r_{it} approaches .5.

Figure 1 also illustrates that in higher YOS cells r_{it} will be higher for each and every value of A_{it}. Again, this is due to the fact that the cohort at YOS $t' > t$ will, on the average, have larger values of δ than the cohort at t.

To implement the supply curve empirically, we need estimates of α_{it} and β. One methodology would be to fix the supply curve so that it passes through each (r_{it}, A_{it}) combination under the current system. By this methodology, changes in A_{it} induce movements along this fixed supply curve. To implement this methodology all that we need is an estimate of β. Once β is known, α_{it} is solved for analytically as $\beta A^c_{it} - \ln(r_{it}/1-r_{it})$, where A^c_{it} is the annualized cost of leaving under the current system. The constant term α_{it} essentially represents the average value of tastes among those in paygrade i at YOS t.

This methodology assumes that a_{it} is fixed for each grade-YOS combination. Reenlistment rates change here only if the annualized cost of leaving changes. The model is essentially a forward-looking model. However, past pay as well as future pay may affect the reenlistment rate at YOS t. That is, if a change in pay alters the average value of tastes among those surviving to YOS t, r_{it} will change for a given value of A_{it}. For example, if a reenlistment bonus induces more first-term reenlistments, the subsequent second-term reenlistment rate of this cohort of first-term reenlistees will probably decline. The first-term reenlistment bonus serves to induce individuals with low values of δ to stay for a second term. Given the same pay stream after the second term, a smaller fraction will reenlist at the second-term point.

This discussion is important for the analysis of retirement systems that provide cash benefits for individuals who complete 10 years of service. The cash payments may serve to retain individuals who would otherwise choose to leave before YOS 10. That is, the benefits serve to retain individuals with lower values of δ. However, since the average value of δ among those who complete 10 years of service will be lower under such a system, the reenlistment rate will decline, even if the annualized cost of leaving is unchanged. This suggests that the assumption of a fixed supply curve will lead to overprediction of post- 10 year reenlistment rates for retirement plans that provide substantial cash benefits after the 10th year of service.

Unfortunately, little empirical evidence exists on the effects of changes in the reenlistment rate at one YOS point on subsequent reenlistment rates. Kleinman and Shughart (reference 5) tried to test for such an effect, but their data were too weak to determine one. One way to introduce such an effect into the model would be to assume that all individuals who are induced to stay in under a new retirement system to receive cash payments at the 10th year of service will then leave at the end of their enlistment obligations. The assumption here is that the elasticity of the current reenlistment rate with respect to past retention is -1. Call this elasticity η. Minus one is an upper bound (in absolute value) on η, since some of those who are initially attracted only by the near-term benefits may decide to stay subsequently. While the proper value of η is unknown, in the retention analysis we determine how sensitive the estimates are to this elasticity.

DETERMINATION OF THE SLOPE PARAMETER β IN THE REENLISTMENT SUPPLY EQUATION

This section derives various estimates of the slope parameter β in the reenlistment supply equation, and it compares the pay elasticities implied by them with results from previous studies. On the basis of these comparisons, a value of β is chosen for use in the predictions for alternative systems.

To begin with, through a suitable transformation the logistic supply equation can be rewritten as a linear equation where ln denotes natural logarithm:

$$\ln\left(\frac{r_{it}}{1-r_{it}}\right) = \alpha_{it} + \beta A_{it} \tag{4}$$

To derive an estimate of β, a linear regression was estimated between $\ln\left(\frac{r_{it}}{1-r_{it}}\right)$ and calculated values of A_{it} under the current retirement system. Because of a paucity of data, we did not attempt to estimate β separately for each service. Rather, for various year of service intervals, we estimated it using pooled data from the four services. Regressions were estimated for the interval 4-9 YOS, the interval 10-16 YOS, and the interval 4-16 YOS.[1] Observations for years 17-19 were dropped because the geometric growth in the annualized cost of leaving in this interval produced downward biased estimates of β.[2]

One problem apparent in devising an estimate of β from a simple regression between $\ln\left(\frac{r_{it}}{1-r_{it}}\right)$ and A_{it} is that the constant term α_{it} is not the same for each grade-YOS combination. The empirical observations do not represent points along a single reenlistment supply curve. Since the supply curve shifts upward from one year group to the next, the estimate of β from a single regression will be upward biased. To control for this bias, we have included variables correlated with the shifts in the supply curve in order to reduce the bias. These include YOS itself and lnYOS.

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[1] The reenlistment rates used in this analysis were FY 1977 reenlistment rates supplied by the Defense Manpower Data Center (DMDC). Summary reenlistment and continuation statistics for FY 1977 are presented in the next section.

[2] Reenlistment rates approach unity by the 16th year of service. It can be easily seen by plotting the data that if the 17-19 year observations are included, where A_{it} grows very rapidly, estimate of β will be downward biased.

The regression results are shown in tables 1, 2, and 3. These regressions also include dummy variables for Navy, Army, and Marine Corps. Simple regressions are also shown. Estimates of β from the simple regressions always exceed the estimates obtained when proxies for shifts in the supply curve are included, indicating that these estimates are indeed upward biased.

The estimates of β from 4-9 YOS regressions in table 1 and 4-16 YOS regressions in table 3 are reasonably consistent with one another. They are all highly statistically significant, and they do not change much with the form of the supply shift proxy included in the regression. The estimates from the 10-16 YOS regressions in table 2 are considerably smaller.

To see which seems to be the most reasonable estimate of β, we calculated the pay elasticities implied by the different estimates. These pay elasticities were calculated for each grade-YOS combination by determining the effect on the reenlistment rate of a 10 percent increase in military pay (assuming the current retirement system is still in effect). The pay elasticity is the percentage increase in the reenlistment rate divided by the 10 percent increase in pay. The results of these calculations are shown in table 4 for various grade-YOS combinations. The base reenlistment rate for these calculations are Navy reenlistment rates for FY 1977. Elasticities are calculated for three representative estimates of β, .000274 (equation 1 of table 3), .000227 (equation 2 of table 3), and .000158 (equation 2 of table 2). The value of .000274 is the highest estimate of β. Other estimates of β cluster closely around the latter two values.

Our judgement is that the pay elasticities implied by a β of .000227 are the most reasonable. The reason for this belief is that the elasticity for E4 at 4 YOS implied by this value of β is in the mid-range of elasticities estimated from previous studies (see reference 4, table D.1). At this point, this judgment is somewhat subjective. Previous compensation studies have focused primarily on the effect of bonuses on first-term reenlistments, and there exists no generally accepted estimates of pay elasticities in higher YOS cells. The elasticities in table 4 are a first cut at such estimates. On the basis of this analysis, we used a β of .000227 to derive point estimates of the retention effects of alternative retirement systems. Estimates using a β of .0003 are also provided to show how sensitive the results are to this parameter.

TABLE 1

REENLISTMENT SUPPLY EQUATION ESTIMATES YOS 4-9[a]
(Dependent variable = Logit of reenlistment rate)

	(1)	(2)	(3)
Independent variable:			
Constant	-2.0439	-1.0301	-2.0760
A[b]	.000226 (6.37)	.000211 (7.27)	.000215 (7.52)
YOS		.1972 (4.72)	
ln(YOS)			1.2675 (5.00)
Navy		-.4931 (2.53)	-.4931 (2.57)
Army		-.5367 (2.76)	-.5367 (2.80)
Marine Corps		-.8838 (7.88)	-.8838 (4.61)
R^2	.342	.585	.596

[a]t-values in parentheses (not computed for constant term).

[b]ACOL calculated assuming 10 percent personal discount rate and 1.5 percent real wage growth.

TABLE 2

REENLISTMENT SUPPLY EQUATION ESTIMATES YOS 10-16[a]
(Dependent variable = Logit of reenlistment rate)

	(1)	(2)	(3)
Independent variable:			
Constant	.8621	1.3785	.2514
A[b]	.000173 (6.48)	.000158 (7.48)	.000158 (7.51)
YOS		.0515 (1.13)	
ln(YOS)			.7029 (1.16)
Navy		-1.2667 (7.56)	-1.2667 (7.56)
Army		-1.4878 (8.88)	-1.4878 (8.88)
Marine Corps		-1.7101 (10.21)	-1.7101 (10.21)
R^2	.375	.786	.786

[a] t-values in parentheses (not computed for constant term).

[b] ACOL calculated assuming 10 percent personal discount rate and 1.5 percent real wage growth.

TABLE 3

REENLISTMENT SUPPLY EQUATION ESTIMATES, YOS 4-16[a]
(Dependent variable = Logit of reenlistment rate)

	(1)	(2)	(3)
Independent variable:			
Constant	.1454	.2299	-1.0014
A[b]	.000274 (13.99)	.000227 (11.23)	.000223 (11.83)
YOS		.0878 (3.56)	
ln(YOS)			.9450 (4.87)
Navy		-.6759 (3.56)	-.6759 (3.65)
Army		-1.2399 (6.54)	-1.2399 (6.69)
Marine Corps		-1.6191 (8.54)	-1.6191 (8.73)
R^2	.507	.667	.691

[a]t-values in parentheses (not computed for constant term).

[b]ACOL calculated assuming 10 percent personal discount rate and 1.5 percent real wage growth.

TABLE 4

PAY ELASTICITIES IMPLIED BY VARIOUS ESTIMATES OF β

Grade	YOS	Base reenlistment rate[a]	β .000274	β .000227	β .000158
E4	4	.25	3.27	2.71	1.89
E5	8	.56	2.18	1.81	1.26
E6	12	.85	.88	.73	.51
E7	16	.93	.58	.48	.33
E8	21	.56	2.25	1.86	1.29

[a]Navy reenlistment rates for FY 1977.

ANALYSIS OF THREE MILITARY RETIREMENT PLANS

During the course of its evaluation of the PCMC proposal, OSD(MRA&L) devised, and CNA estimated the retention effects of, a range of alternative military retirement systems. These plans can be placed into three classes -- two-tier plans like the RMA plan, trust fund plans like the PCMC plan, and two-tier plans with early withdrawal privileges. The plan finally selected by the Secretary of Defense is a two-tier early withdrawal plan. This plan, an identical two-tier plan without early withdrawal privileges, and the PCMC plan are analyzed in the following two sections. The first section discusses the plans, while the second section presents the retention analysis of these plans.

THE PLANS

The plans to be analyzed are described in tables 5, 6, and 7. The two-tier plan is presented in table 5. It is similar to the RMA plan. This plan maintains the 20-year retirement system but at reduced annuity levels. It provides a first-tier annuity until age 60 and a second-tier annuity after age 60. For a 20-year retiree, the first-tier annuity is 37.5 percent of high-two years' average base pay. Thus, this plan reduces a 20-year retiree's annuity by about 25 percent until age 60.[1] The first tier annuity rises by 2.5 percent for each year of service after 20 years. For those who serve past 20 years, the percentage reduction in annuities to age 60 declines.

Between ages 60 and 65, the second-tier annuity rises almost to current system levels. For example, for the 20-year retiree, the second-tier annuity is 48.75 percent of high-two years' average base pay, compared with 50 percent of terminal base pay under the current system. However, at age 65 the second-tier annuity is partially reduced by the individual's social security benefit. Like today's system, retirement annuities would be indexed by changes in the Consumer Price Index (CPI). This plan would also vest those who leave with between 10 and 19 years of service with an old-age annuity, a feature of earlier retirement proposals.

The plan is in the mid-range of two-tier plans evaluated by OSD(MRA&L). It is somewhat less generous than the earlier RMA RMA plan. The main differences are that the first tier annuity is lower, and it lasts until age 60 rather than the date the individual would have completed 30 YOS, as in the RMA plan. However, it is more generous than the 1971 IAC plan.

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[1] Because this plan bases the annuity on high-two years' average base pay, the percentage reduction to age 60 is slightly more than 25 percent.

TABLE 5

TWO-TIER ANNUITY PLAN

	First-tier annuity	Second-tier annuity
Eligibility for vesting:	20 YOS	10 YOS
Annuity begins:		
For those who complete 20 YOS	Immediately upon retiring	Age 60
For those who complete 10-19 YOS	None	Age 60
Annuity multiplier:	.375 + .025x(YOS-20)	.2125 + .0275x(YOS-10)
Annuity base:	High-two years' average basic pay	Same
Social security offset at age 65:	None	.0125 x YOS x (Social security benefit attributable to military service)

TABLE 6

THE PCMC RETIREMENT PLAN

Old age annuity:	
Age eligibility:	
10-19 YOS	Age 62
21-29 YOS	Age 60
30 YOS	Age 55
Annuity multiplier:	.2125 + .0275x(YOS-10)
Annuity base:	High three years' average basic pay
Social Security offset:	.0125 x YOS x total Social Security benefit
Trust Fund	
Contributions:	
6-10 YOS	15% of yearly basic pay
11-20 YOS	25% of yearly basic pay
21-25 YOS	15% of yearly basic pay
26-30 YOS	5% of yearly basic pay
Eligibility for withdrawals:	completion of 10 YOS
Withdrawals while on active duty:	50% of cumulative fund at YOS 10 plus 50% of yearly contributions thereafter

TABLE 7

THE OSD RETIREMENT PLAN

Allowable Withdrawals:

20 months' basic pay between YOS 10 and YOS 15 (maximum schedule is 10 months' basic pay at YOS 10 and 2 months' basic pay in YOS 11-15)

Annuities:	First-tier annuity	Second-tier annuity
No withdrawals	same as table 5	same as table 5
Maximum withdrawals	table 5 annuity minus .09	same as table 5

Next let us examine the PCMC plan. It is described in table 6. The PCMC recognized that a retirement system such as RMA or the two-tier plan just described would have lower personnel retention than the current system. In its view, the purpose of a change in the retirement system should not simply be to reduce retired pay, but to restructure the compensation system to place more benefits "up front." The PCMC accomplished such a restructuring in its retirement proposal by breaking the military retirement system into two parts, an old- age annuity and a trust fund available to individuals who complete 10 years of service. This fund would be financed by annual contributions from DoD and would collect interest. While the stated purpose of the trust fund was to facilitate the service member's transition back to civilian life, the PCMC recommended that individuals be allowed to withdraw 50 percent of their accumulated funds while remaining on active duty. Their trust fund plan thus has the appearance of an institutionalized bonus system.[1] The PCMC's hope was that the availability of these cash benefits after 10 years of service would provide increased retention incentives for younger personnel.

Since the trust fund and the old-age annuity grow fairly smoothly with years of service, the PCMC plan effectively eliminates the 20-year military retirement system. It replaces the carrot of 20-year retirement with a much smoother set of retention incentives. Relative to the current system, the PCMC plan would cut benefits for 20-25 year retirees drastically. As we shall see, it provides

[1]The PCMC felt -- and it was clear from the retention analysis of the plan -- that not allowing withdrawals while on active duty would hurt retention.

lower retention incentives for personnel with between 10 and 19 years of service. However, because benefits for 30-year retirees are about the same as under the current system, the PCMC system has a much stronger "pull" to the 30-year point among personnel with over 20 years of service. In fact, the PCMC plan provides the strongest retention incentives for older personnel of any of the plans considered by OSD(MRA&L).

During the OSD review of the PCMC proposal, the services voiced strong objections. The first was that the PCMC cut benefits for 20-year retirees too much. The second was that the services perceive the availability of 20-year retirement as an important management tool which they do not want to give up. The services do not want to retain as many people over 20 years of service as would stay under the PCMC proposal. Attention then turned to systems that maintain 20-year retirement, but which also provide some cash payments for those who complete 10 years of service. These payments were viewed as necessary to counter the adverse retention incentives provided by a simple reduction in post-20-year retirement annuities. Thus, the concept of "early withdrawals" originated. Individuals would be allowed to withdraw against their prospective retirement annuities upon completing 10 years of service. The more they withdraw, the more their annuities would be reduced when and if they retire. Individuals may simply take their allowable withdrawals and leave upon completion of 10 years of service.

The OSD early withdrawal plan is described in table 7. For individuals who never make withdrawals, the first- and second-tier annuities are the same as for the two- tier plan described in table 5. Individuals are allowed to withdraw a total of 20 months basic pay between their 10th and 15th years of service. They are allowed to withdraw 10 months' basic pay after the 10th year and two months' basic pay after each of the next five years. Or, they may withdraw less after the 10th year but more later. Individuals who withdraw all they can but who complete 20 years of service will have their first-tier annuity reduced by 9 percentage points. A 20-year retiree would thus get a first-tier annuity of 28.5 percent of high two years' average basic pay rather than 37.5 percent. Individuals who withdraw less would of course have smaller reductions. Individuals who make withdrawals and then leave would not get an old-age annuity. The withdrawals allowed in the OSD plan are smaller than those allowed in some other plans considered by OSD. The primary reason for reducing the allowable withdrawals was to reduce the near-term cost increases that will be incurred after the plan is implemented.[1]

THE RETENTION ANALYSIS

The retention analysis proceeds as follows. First, we review the retention statistics for the current system. After that, we discuss the issue of the appropriate discount rate to use in the analysis. Next, we compare values of the annualized cost of leaving for the different plans. Then, we examine the retention predictions and the steady-state force profiles and accession requirements that are predicted for the various plans. Finally, the plans are evaluated in general terms.

Retention Patterns Under the Current System

Table 8 shows some summary retention statistics under the current retirement system. These statistics are based on FY 1977 data supplied by the Defense Manpower Data Center (DMDC). For six different YOS intervals, the table shows average yearly reenlistment rates, average yearly continuation rates, and cumulative continuation rates.[2] It illustrates several things.

First, reenlistment rates are typically much lower than continuation rates. The total continuation rate is a weighted average of the reenlistment rate and the continuation rate of those not at ETS. Between the end of the first-term and the 20th year of service, the non- ETS continuation rate is usually over 98 percent. Second, first-term reenlistment rates are fairly low -- less than 30 percent. Subsequent reenlistment rates rise monotonically up to 20 years. This rise is clearly due in part to the increasing pull of the current retirement system as individuals approach 20 years of service. The very high retention generated by the current retirement system between the 10th and 20th years of service is evident. For DoD as a whole, the average yearly continuation rate between 10 and 20 years of service is about 70 percent. The 70 percent retention over this 10 year period is in sharp contrast to 6-10 year retention, which is less than 50 percent. Fourth, among the four services, there is considerable variation in retention, it being highest in the Air Force and lowest in the Marine Corps.

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[1] All of the trust fund and early withdrawal plans that were considered would entail near-term cost increases. Paradoxically, however, the plans that have the higher near-term costs would save more money in steady state. This is because plans that have more up- front money have lower retirement annuities, and it is the cut in retirement annuities that leads to long-run cost savings.

[2] Year-by-year data are shown for each service in appendix A.

TABLE 8

SUMMARY RETENTION STATISTICS,
CURRENT RETIREMENT SYSTEM

		Years of service				
		0-5	6-10	11-15	16-20	21-30
Navy	R[b]	.245	.473	.811	.957	-
	$\overline{CR}$[c]	.778	.871	.948	.930	.706
	Cum[d]	.284	.503	.765	.905	.031
Air Force	R	.377	.614	.922	.988	-
	$\overline{CR}$	.815	.893	.872	.993	.661
	Cum	.351	.568	.867	.956	.016
Army	R	.286	.552	,768	.928	-
	$\overline{CR}$	.757	.855	.924	.979	.722
	Cum	.249	.457	.672	.901	.038
Marine Corps	R	.239	.506	.801	.936	-
	$\overline{CR}$	.740	.826	.909	.978	.737
	Cum	.221	.384	.621	.895	.047
All DoD	$\overline{CR}$	.773	.868	.945	.984	.701
	Cum	.276	.492	.756	.924	.029

[a] Based on FY 1977 data supplied by Defense Manpower Data Center.

[b] Except for the 0-5 interval, R is a geometric average of reenlistment rates for interval shown. For 0-5 interval, R is the first-term reenlistment rate. It is the 3rd year reenlistment rate for the Army and the 4th year rate for the other services.

[c] $\overline{CR}$ is geometric average of cumulative continuation rate in the interval shown.

[d] Cum is the cumulative continuation rate in interval shown.

[e] All DoD reenlistment rates not computed.

Table 9 shows no reenlistment rates beyond 20 years of service. The distinction between reenlistment rates and total continuation rates is not very meaningful after 20 years. Unlike the interval before 20 years of service, reenlistment contracts are not rigidly enforced, and personnel who have not reached the end of their enlistment contracts are frequently allowed to retire. As a consequence, reenlistment rates and non- FTS continuation rates are quite similar after 20 years. Both rates reflect voluntary supply behavior. Therefore, after 20 YOS the total continuation rate is probably a better measure of voluntary supply behavior than is the reenlistment rate.

Choice of a Discount Rate

The first issue that we must address in the retention analysis is the choice of a discount rate. The choice is particularly crucial for analysis of plans with up-front cash benefits. The higher the discount rate, the more attractive these plans will appear to young people relative to the current system. At low discount rates, these plans might even appear worse to young people than the current system.

There have been several previous studies of personal discount rates. The most recent, analytically sound study is that of Gilman (reference 6). He found that discount rates vary inversely with both age and income level. Young people, especially, have a high preference for current over deferred compensation and discount future dollars heavily. Using his basic fitted equation, we have derived point estimates of discount rates of enlisted personnel with various years of service. For those just entering service at age 19, the estimate is 20 percent. For those with 10 years (age 29), the estimate is about 12 percent. The discount rate does not decline to 5 percent until about 20 years of service.[1]

While the empirical evidence on personal discount rates is by no means conclusive, it does suggest that young personnel have fairly high discount rates. On the basis of our survey of empirical evidence on discount rates, we have chosen to use a discount rate of 10 percent throughout the retention analysis. It may be a conservative estimate of the personal discount rates of young personnel, but we decided to err on the conservative side.

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[1] Gilman's basic fitted equation is, Discount Rate = .429 - .011(AGE) + .00011(AGE^2) - .0000062(INCOME) + .015(SEX=FEMALE) + .015(RACE=BLACK) - .00075(MARITAL STATUS=MARRIED).

TABLE 9

ANNUALIZED COST OF LEAVING VALUES FOR VARIOUS GRADE-YOS COMBINATIONS, 10 PERCENT DISCOUNT RATE

(High Economic Assumptions)[a]

Grade	YOS	Current	TT Plan	PCMC Plan	OSD Plan
E4	4	1,235	749	1,505	1,485
E5	9	3,078	2,168	6,698	4,450
E6	12	5,357	3,741	3,007	3,869
E7	16	14,511	10,347	4,666	8,336
E8	21	1,493	2,727	7,166	4,198
E9	23	3,112	3,780	9,845	6,421

[a] "High" economic assumptions are 1.5 percent yearly real wage growth and 2.5 percent reenlistment rate.

The discount rates cited above were calculated using 1977 average RMC by length of service for enlisted personnel. The sex, race, and marital status variables were ignored.

Values of the Annualized Cost of Leaving for Alternative Retirement Systems

For a 10 percent discount rate, table 9 shows values of the annualized cost of leaving under the current system and the three alternative retirement systems. Recalling the retention model developed earlier, the negative of the numbers in table 9 is interpreted as the value of the taste for service factor δ that separates stayers from leavers (ignoring the random factor ϵ). Looking first at the values of the annualized cost of leaving for the current system, the increasing pull of the current retirement system as individuals approach 20 years of service is evident. Again, ignoring the random factor ϵ, an E-4 at YOS only has to have a negative taste factor greater than -$1.235 before he would be induced to leave. An E-6 at 16 years would have to have a negative taste factor greater than -$14,511 before he would be induced to leave. Once individuals become vested in the retirement system, the annualized cost of leaving falls sharply. The current pattern of how retention in early YOS cells, high retention in YOS cells just prior to 20 years, and low retention thereafter is predictable from these annualized cost of leaving numbers.

It should be evident that the pure two-tier plan reduces the annualized cost of leaving prior to YOS 20. This plan reduces post 20-year retirement annuities without any compensating benefits prior to 20 years. It vests individuals who complete 10 years in an old-age annuity, but its value to young people is rather small.[1] It is clear that prior to 20 YOS retention will be lower than today's retention under this two-tier system. This two-tier plan does offer increased retention incentives for personnel over YOS 20, and should therefore serve to increase their retention.

The annualized cost of leaving values for the OSD plan were computed assuming maximum withdrawals, which appears to be the optimal withdrawal schedule for someone with a 10 percent discount rate. At this discount rate, the OSD plan appears to offer higher retention incentives than the current system prior to 10 years of service. That is, the withdrawals allowed between the 10th and 15th years more than compensate for the reduced annuities after 20 years.

An important point is that while the plan does appear to offer increased retention incentives for individuals facing a first-term reenlistment decision at YOS 4, the increase is slight. The plan will not have very much impact on first-term reenlistments. We expect that it will have two effects prior to YOS 10. First, it will encourage individuals who would otherwise leave after a second term to stay in service until they are eligible for their withdrawals. Second, it may encourage individuals who now reenlist after a first term for four years to reenlist for six years. This latter effect we expect to be especially important in occupational areas that offer Zone A (first-term) bonuses. Since Zone A bonus multipliers are typically larger than Zone B (second-term) bonus multipliers, two more years of bonus payments coupled with the withdrawals available at YOS 10 may provide a strong incentive to six year reenlistments. Just by encouraging 6-year reenlistments, the OSD plan may have a significant effect on 6-10 YOS retention.

Relative to the current system, the PCMC plan offers the most radically changed pattern of retention incentives. Prior to YOS 10 it offers a larger increase in retention incentives than the OSD plan. This is due to the fact that the PCMC plan has a larger trust fund accumulation at YOS 10 than the early withdrawals available under the OSD plan ($7,759 versus $6,836 for an E-5), and because the PCMC plan offers a vested old- age annuity at YOS 10 whereas the OSD plan does not.

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[1]At a 10 percent discount, the present value of the old age annuity at YOS 10 is about $500.

Between YOS 10 and YOS 20, retention incentives decline more under the PCMC plan than in either of the other two alternatives. However, after YOS 20 the PCMC offers the largest increase in retention incentives of any of the alternatives. The PCMC plan has an increasingly strong draw to YOS 30 because those who complete 30 years receive their old-age annuity at age 55 rather than age 60 (see table 6).

Several conclusions follow from this analysis. The two-tier plan would result in uniformly lower retention than the current system prior to YOS 20, but higher retention thereafter. The OSD and PCMC plans would result in higher retention than the current system prior to YOS 10, lower retention between YOS 10 and YOS 20, and higher retention thereafter. The retention changes in all three intervals would be larger under the PCMC plan than the OSD plan. Indeed, the OSD plan evolved in part because it represented a less significant departure from the current system.

For brevity, we have not shown annualized cost of leaving values for discount rates other than 10 percent. With one exception, an ordinal ranking of the plans is unaffected by a change in the discount rate. That exception is that at low discount rates (e.g., .05) the PCMC and OSD plans appear to offer no greater retention incentives to young personnel -- and in many cases lower incentives -- than the current system. Because such discount rates appear to be much lower than accepted estimates of personal discount rates of young personnel (even 10 percent may be too low), we have not bothered to make retention estimates under such assumptions. For a range of "reasonable" assumptions, the next section presents quantitative estimates of enlisted retention for these three retirement plans.

<u>The Retention Estimates</u>

This section shows the basic retention estimates for the three alternatives. The assumptions underlying these estimates are (1) a personal discount rate of 10 percent, (2) 1.5 percent yearly real wage growth in both the military and civilian sectors, and (3) a real interest rate of 2.5 percent. Predictions were made using slope coefficients in the supply equation of .000227 and .0003, respectively. The first coefficient was derived from the regression analysis discussed above. Predictions obtained with the latter coefficient allow us to see how sensitive the results are to a supply equation with larger pay elasticities.

Remember from the above discussion that a supply equation that assumes a fixed YOS constant term will tend to overpredict reenlistment rates under the OSD and PCMC plans in YOS 11-15. It may also <u>underpredict</u> reenlistment rates in this YOS interval under a two- tier plan, since those who stay for a third term under this plan will have a larger average taste for service value than those staying for a third term under the current system.

To see how sensitive reenlistment rates, and consequently continuation rates in YOS 11-15 are to the assumption of a fixed constant term in the supply equation, we produced estimates for three different assumptions about the elasticity of reenlistments at YOS t and retention prior to YOS t (η). Alternative values of η used are 0, -.5, and -1. Reenlistment rates in YOS 11-15 were adjusted downward by this elasticity times the percentage increase in retention prior to YOS 10. We have no existing estimates of the elasticity of reenlistments to past retention, but predictions derived from different values of this elasticity provide a test of how sensitive the resulting force structures are to it. Without any supporting evidence, we believe that the predictions derived with an elasticity of -.5 are the most reasonable. Theoretically, η should be greater than zero (in absolute value); however 1 is the upper bound value (in absolute value), and it is unlikely that η is that large.

Before presenting results, two points should be made. First, the force profiles that are derived are the steady-state profiles that are predicted after a new system is fully implemented. They do not represent forces that will evolve during the transition from one system to another. The second is that these profiles do not account for changes in compensation or various personnel management actions that might be undertaken to change the force structure. Indeed, it will become clear that the two-tier plan will provide a force with a higher first-term career mix. Under this plan, more bonus money will be needed to maintain the same first- term career mix as under the current system.

To give the reader a feel for how reenlistment rates are predicted to change under each plan, tables 10, 11, and 12 show the estimated impact of each plan on Navy reenlistment rates. Estimates are shown for five different years of service, 4, 8, 12, 16, and 20. These years of service correspond roughly to the first, second, third, fourth, and fifth terms of service. Six cases are shown for each plan. The first three cases are for β equal to .000227 and η equal to 0, -.5, and -1 respectively. The second three cases are for β equal to .0003 together with the above values of η. The different values of η serve to alter only the 12th year rate.

Looking first at the two-tier plan for η equal to 0, first-term (YOS 4) reenlistments are predicted to fall by six to eight percent, second-term (YOS 8) reenlistments by eight to 10 percent, third-term (YOS 12) rates by five to seven percent, and fourth-term (YOS 16) reenlistments by six to nine percent. Third-term rates improve when values of η equal to -.5 and -1 are used. That is,

TABLE 10

NAVY REENLISTMENT RATES UNDER CURRENT SYSTEM AND RATES PREDICTED FOR TWO-TIER SYSTEM

			YOS				
	β	η	4	8	12	16	20
Current			.245	.566	.852	.944	.375
Two-tier	.000227	0	.230	.523	.806	.884	.429
		-.5	.230	.523	.823	.884	.429
		-1	.230	.523	.840	.884	.429
	.0003	0	.225	.509	.789	.855	.447
		-.5	.225	.509	.811	.855	.447
		-1	.225	.509	.835	.855	.447

TABLE 11

NAVY REENLISTMENT RATES UNDER CURRENT SYSTEM AND RATES PREDICTED FOR OSD RETIREMENT SYSTEM

			YOS				
	β	η	4	8	12	16	20
Current			.245	.566	.852	.944	.375
OSD plan	.000227	0	.247	.592	.805	.837	.481
		-.5	.247	.592	.753	.837	.481
		-1	.247	.592	.700	.837	.481
	.0003	0	.247	.600	.787	.778	.516
		-.5	.247	.600	.732	.778	.516
		-1	.247	.600	.677	.778	.516

TABLE 12

NAVY REENLISTMENT RATES UNDER CURRENT SYSTEM AND RATES PREDICTED FOR PCMC RETIREMENT SYSTEM

			YOS				
	β	η	4	8	12	16	20
Current			.245	.566	.852	.944	.375
OSD plan	.000227	0	.263	.601	.799	.731	.562
		-.5	.263	.601	.736	.731	.562
		-1	.263	.601	.674	.731	.562
	.0003	0	.269	.613	.779	.603	.621
		-.5	.269	.613	.711	.603	.621
		-1	.269	.613	.643	.603	.621

when personnel with lower tastes leave earlier, the third-term rate comes closer to the current system rate.

At this point, the reader may note that the fourth-term (YOS 16) rate should show some improvement as well. A complete model would account for the changes in the taste distribution in each and every YOS as past and future compensation change. This model is not complete in this regard. As a practical matter, adjustment to fourth-term reenlistment rates to account for changes in the taste distribution will have little effect on the force profiles derived for the two-tier plan. This is because only a small fraction of the force reach ETS each year between YOS 16 and YOS 20, and because the rates are very high to begin with.

Under the OSD plan, the first-term (YOS 4) rate is predicted to rise only slightly. The second-term (YOS 8) rate is predicted to rise by only 5 to 6 percent. This change is not very large, and intuitively one might suspect that it would be larger since the individual who stays for two more years will be eligible to withdraw about $6,800. The reason that the increase is not larger is that the model weighs the annualized cost of leaving over this 2-year horizon with the annualized cost of leaving under the current system over a 12-year horizon. The $6,800 increase in pay (appropriately discounted) for staying 2 more years is not considered in isolation.

The decline in third-term rates ranges between 6 percent and 21 percent depending upon β and η. When η equals 0 (the model is essentially forward-looking), the third-term rates do not differ much for the OSD and two-tier plans. That is, at YOS 12 the returns to staying are about the same under the two plans. However, even if the returns to staying are similar, more people should be predicted to leaving at YOS 12 under the OSD plan since the taste distribution among those at YOS 12 will differ for the two plans. Cases where η equals -.5 and -1 adjust the reenlistment rates for the differing taste distributions and show lower rates for the OSD plan. The reenlistment rate at YOS 16 is lower for the OSD plan than the two-tier plan, but the rate for YOS 20 is higher.

Reenlistment rates change more under the PCMC plan than the other plans at each of the five years of service shown. This is true regardless of the values of β and η. For brevity, we do not show the predicted changes in reenlistment rates for the other services. The changes in the Army and Marine Corps are about the same as those for the Navy. Smaller changes were predicted for the Air Force. The Air Force generally has higher reenlistment rates than the other services; the pay elasticities implied by the reenlistment supply equation are therefore smaller for the Air Force than the other three services.

We now turn to the estimates of continuation rates and the steady-state force profiles that are predicted to evolve under these three plans. Once reenlistment rates were estimated for each plan, total yearly continuation rates were derived using equation (2). Judgments were made about how each plan would change reenlistment contract lengths and hence f_{it} in equation (2). For the two-tier plan, we used the current system pattern except for assuming that f_{it} is unity after YOS 20. This exception was also maintained for the OSD and PCMC plans. In addition, two other assumptions were made for these latter two plans. First, we assumed that smaller fractions of the force would come up for reenlistment in YOS 9 and 10 under the OSD and PCMC plans. Except for the Air Force, we assumed that only 15 percent of each year group would make a reenlistment decision in these YOS cells rather than today's percentages.[1] The percentage facing a reenlistment decision in YOS 11 was then increased by the percentage point reductions in YOS 9 and 10. Second, for the OSD and PCMC plans, we generally assumed that 25 percent of the force would reach ETS each year between YOS 10 and YOS 20. Currently, the fraction reaching ETS each year is much lower in this interval. However, the OSD and PCMC plans do not offer the same incentive to sign long reenlistment contracts and it was therefore judged that larger fractions of the force would reach ETS each year under these systems.

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[1]The Air Force provided us with their judgment about how reenlistment patterns in the Air Force would change under these three plans, and their fractions were used throughout the analysis of Air Force data. Their pattern also shows a decline in f_{it} in YOS 9 and 10 and an increase in YOS 11.

Tables 13, 14, and 15 show the all-DoD retention and force structure predictions for each plan for each combination of values of β and η. Each table shows the average yearly continuation rate, the cumulative continuation rate, the percentage distribution of the force, and the number of careerists (number with more than 5 YOS) for four different YOS intervals. Comparable tables for the individual services are provided in appendix B. Yearly accessions required to maintain a 1.8 million person force are shown in table 16.

The two-tier plan would produce uniformly lower retention than the current system prior to YOS 20, but slightly higher retention thereafter. Depending upon the particular assumptions about β and η, the number of first-termers is predicted to increase, and the number of careerists to decline, by between 23,000 (case 3) and 45,000 (case 4). Yearly accession requirements increase by between 9,000 and 17,000. Case 3 (β = .000227 and η = -1) is probably overly optimistic since -1 is an extreme value of η. Holding β constant, results for η = 0 and η = .5 are reasonably similar. This suggests that the range of likely decline in the career force is between 29,000 and 45,000 (a reduction of between 4 and 6 percent) and the increase in yearly accessions is between 11,000 and 17,000. In addition to a decline in the number of careerists, there is a reduction in their average years of experience.

Unlike the two-tier plan, the OSD plan would lead to increased retention prior to YOS 11. In cases 1 through 3, cumulative retention to YOS 11 is predicted to rise by 16 percent, while in cases 4 through 6 it is predicted to rise by 18 percent.

Retention is predicted to decline between YOS 11 and YOS 20, and the declines are predicted to be larger than in the two-tier plan. These predicted declines occur both because of the larger decline in the annualized cost of leaving after about YOS 12, and because the early withdrawal payments serve to reduce the average taste for service among those surviving to YOS 11.

The decline in retention in YOS 11-20 ranges between 24 percent (case 1) and 39 percent (case 6). Cases 2 and 5 probably provide the most reasonable estimates -- 29 percent and 34 percent, respectively. The OSD plan is predicted to generate higher retention after YOS 20. The predicted increase is much larger than the increase predicted for the two-tier plan.

Generally speaking, the drops in the career force that are predicted to occur under the two-tier plan would not occur under the OSD plan. Cases 3 and 6 (η equal to -1 in both cases) indicate significant drops, but these cases are based on an extreme assumption. In our opinion, the other cases represent a more reasonable range of estimates. The two cases in which η equals 0 show a slightly increased number of careerists, and slightly reduced accession requirements. The two cases where η equals -.5 indicate a

TABLE 13

RETENTION UNDER CURRENT SYSTEM AND
PREDICTIONS FOR TWO-TIER PLAN, ALL DoD

	YOS Interval			
	0-5	6-10	11-20	21-30
Current System				
$\overline{CR}$	.773	.868	.964	.701
Cum	.276	.491	.696	.029
PDF	.561	.219	.192	.029
Careerists = 790,000				
Two-Tier Plan Case 1				
$\overline{CR}$	.769	.861	.955	.712
Cum	.269	.473	.630	.033
PDF	.579	.218	.175	.028
Careerists = 758,000				
Case 2				
$\overline{CR}$	.769	.861	.957	.712
Cum	.269	.473	.646	.033
PDF	.577	.217	.178	.029
Careerists = 761,000				
Case 3				
$\overline{CR}$	.769	.861	.960	.712
Cum	.269	.473	.662	.033
PDF	.574	.216	.180	.029
Careerists = 767,000				
Case 4				
$\overline{CR}$	.768	.859	.951	.706
Cum	.267	.468	.604	.031
PDF	.586	.218	.169	.027
Careerists = 745,000				
Case 5				
$\overline{CR}$	.768	.859	.954	.706
Cum	.267	.468	.624	.031
PDF	.583	.216	.173	.028
Careerists = 751,000				
Case 6				
$\overline{CR}$	.768	.859	.957	.706
Cum	.267	.468	.645	.031
PDF	.580	.215	.176	.029
Careerists = 756,000				

TABLE 14

RETENTION UNDER CURRENT SYSTEM AND
PREDICTIONS FOR OSD PLAN, ALL DoD

	YOS Interval			
	0-5	6-10	11-20	21-30
Current System				
$\overline{CR}$	.773	.868	.964	.701
Cum	.276	.491	.696	.029
PDF	.561	.219	.192	.029
Careerists = 790,000				
OSD Plan Case 1				
$\overline{CR}$	.774	.892	.938	.759
Cum	.278	.565	.529	.063
PDF	.556	.224	.183	.036
Careerists = 799,000				
Case 2				
$\overline{CR}$	.774	.892	.932	.759
Cum	.278	.565	.493	.063
PDF	.564	.227	.175	.034
Careerists = 784,800				
Case 3				
$\overline{CR}$	.774	.892	.925	.758
Cum	.278	.565	.459	.063
PDF	.571	.231	.166	.032
Careerists = 772,000				
Case 4				
$\overline{CR}$	.774	.894	.931	.766
Cum	.278	.572	.491	.070
PDF	.557	.226	.179	.038
Careerists = 797,000				
Case 5				
$\overline{CR}$	.774	.894	.924	.766
Cum	.278	.572	.456	.070
PDF	.565	.229	.170	.036
Careerists = 783,000				
Case 6				
$\overline{CR}$	.774	.894	.917	.766
Cum	.278	.572	.422	.670
PDF	.573	.233	.162	.632
Careerists = 769,000				

TABLE 15

RETENTION UNDER CURRENT SYSTEM AND PREDICTIONS FOR PCMC PLAN, ALL DoD

	YOS Interval			
	0-5	6-10	11-20	21-30
Current System				
$\overline{CR}$	.773	.868	.964	.701
Cum	.276	.491	.696	.029
PDF	.561	.219	.192	.029
Careerists = 790,000				
OSD Plan Case 1				
$\overline{CR}$	.777	.894	.921	.847
Cum	.284	.570	.440	.189
PDF	.548	.227	.181	.044
Careerists = 814,000				
Case 2				
$\overline{CR}$	.777	.894	.914	.847
Cum	.284	.570	.407	.189
PDF	.556	.231	.172	.042
Careerists = 799,000				
Case 3				
$\overline{CR}$	.777	.894	.907	.847
Cum	.284	.570	.378	.189
PDF	.565	.234	.162	.039
Careerists = 783,000				
Case 4				
$\overline{CR}$	.779	.896	.901	.863
Cum	.284	.578	.353	.230
PDF	.550	.231	.176	.043
Careerists = 810,000				
Case 5				
$\overline{CR}$	.779	.896	.894	.863
Cum	.287	.578	.324	.230
PDF	.559	.235	.166	.040
Careerists = 794,000				
Case 6				
$\overline{CR}$	.779	.896	.886	.863
Cum	.287	.578	.298	.230
PDF	.568	.239	.156	.037
Careerists = 778,000				

TABLE 16

YEARLY ACCESSION REQUIREMENTS, ALL DoD
(in thousands)

Current	Case	Two-tier plan	OSD plan	PCMC plan
383	1	396	379	374
	2	394	384	379
	3	392	289	385
	4	400	380	375
	5	398	385	381
	6	396	391	387

slightly reduced career force and slightly increased accession requirements. Overall, these results are judged to indicate that the OSD plan would produce about the same career force and yearly accession requirements as the current system. Our judgement is that the case 2 or case 4 estimates (η equal to -.5) are most realistic.

The most extreme force structure changes are predicted to occur under the PCMC plan. First, this plan is predicted to have a slightly greater impact on retention prior to YOS 11 than the OSD plan. The predicted increases range between 20 and 23 percent in contrast to the 16 to 18 percent increase predicted for the OSD plan. Yet, much larger declines are predicted between YOS 11 and YOS 20. The range of decreases in this interval is from 37 percent (case 1) to 57 percent (case 6). The case 2 and case 5 estimates, which we consider to be the most reasonable, are 42 percent and 53 percent, respectively.

The most dramatic change in retention is predicted to occur after YOS 20. The PCMC plan provides a large return for completing YOS 30 as opposed to leaving in any year prior to YOS 30. It is therefore predicted that 18 to 23 percent of those completing 20 YOS would complete 30 YOS under the PCMC plan. This is in sharp contrast to the current system, where only 2.9 percent do so.

Note that the post-20-YOS retention estimates are supply-based. That is, we have not attempted to account for personnel management (demand) in this interval. The services have stated that they would not want to keep as many people after YOS 30 as would want to stay under the PCMC plan. The most often cited reason is that maintaining so many people after 20 years would lead to grade stagnation and stifle promotions. Many would have to be involuntarily separated. We have not attempted to account for personnel management actions in this interval for several reasons. First, the services have not been able to articulate what those actions would be. Second, we suspect that management actions in this interval will depend in large part upon what exactly happens to earlier retention. Third, there is evidence that the services will not separate an individual when it is to the individual's financial detriment. Unless severance pay in the post-20-year interval is generous, the services would be unlikely to pursue aggressive separation policies rather than allowing personnel to continue to YOS 30.

Most cases indicate that the PCMC plan would increase the career force and reduce yearly accession requirements. This happens because the predicted increases in retention prior to YOS 11 and after YOS 20 more than offset the large declines between YOS 11 and YOS 20.

Evaluation

How do we evaluate these different plans for their effects on the output of "national defense?" Which force is most desirable? These are difficult questions. There is no generally accepted measure of the effectiveness of forces with different experience distributions. Both the first-term/career mix and the distribution of careerists have to be examined. Holding the first-term/career mix constant, the effectiveness of various forces depends upon the rate at which "career" personnel (those with more than one term of service) with different experience levels substitute for one another. Only if career personnel with different experience levels are highly substitutable for one another is the first-term/career mix the only measure by which different forces need be judged.[1]

These problems aside, it is clear that the two-tier plan would reduce effectiveness. It increases the first-term/career mix, and it reduces the average experience level of the career force. The recent Defense Resource Management Study (reference 8) found that even at today's relative costs of first-termers and careerists, many occupational areas have too many first-termers and too few careerists. A two-tier plan would clearly move these occupational

[1] Horowitz and Sherman (reference 7) provide one of the few studies of the effect of experience on productivity. They found that experience matters and that personnel with different experience levels are not perfectly substitutable for one another.

areas in the wrong direction. If such a plan were adopted, the Administration and the Congress would certainly have to be cognizant of the need to pay larger bonuses in such skill areas.

Realtive to the current system, and to each other, the OSD and PCMC plans are harder to evaluate. They keep the first-term/career mix roughly constant (in some cases reducing it), but they alter the distribution of careerists. In the case of the PCMC plan, the distribution of careerists is changed quite drastically. The services' strong opposition to, and OSD's lack of support for, the PCMC plan is due in part to this fact. Yet, in our opinion, the services' opposition has been based as much on emotion as on hard analysis. Clearly the next step is to develop the analytical tools for evaluating the effectiveness of different force structures.

REFERENCES

1. Final Report of the President's Commission on Military Compensation, Washington, D.C., April 1978

2. Center for Naval Analyses, Memorandum (CNA)78-0362, "Analysis of the Retention Impact of the Proposed Retirement System," by John T. Warner, Unclassified, March 1978

3. Gotz, Glenn, and John J. McCall, "The Retirement Decision: A Numerical Analysis of a Dynamic Retirement Model," WN-9628-AF, The Rand Corporation, Santa Monica, California, March 1977

4. Enns, John H., "Reenlistment Bonuses and First-Term Retention," The Rand Corporation, R-1935-ARPA, September 1977

5. Center for Naval Analyses, Research Contribution 269, "The Effects of Reenlistment Bonuses." by Samuel Kleinman and W.F. Shughart II, Unclassified, September 1974

6. Gilman, Harry J., "Determinants of Implicit Discount Rates," unpublished manuscript, September 1976

7. Center for Naval Analyses, Study 1090, "Personnel Performance and Ship Condition," by Stanley Horowitz and CDR Allan Sherman, Unclassified, March 1977

8. Rice, Donald B., Final Report, Defense Resource Management Study, United States Government Printing Office, Washington, D.C., February 1979

APPENDIX A

FY 1977 RETENTION STATISTICS

APPENDIX A

FY 1977 RETENTION STATISTICS

Tables A-1, A-2, and A-3 show FY 1977 reenlistment rates, yearly fractions at reenlistment, and yearly continuation rates by years of service for each branch of service.

TABLE A-1

YEARLY REENLISTMENT RATES, FY 1977

YOS	Navy	Air Force	Army	Marine Corps
1	0.412	0.0446	0.31	0.29
2	0.182	0.103	0.165	0.141
3	0.21	0.[illegible]82	0.[illegible]	0.226
4	0.245	0.[illegible]76	0.[illegible]	0.[illegible]9
5	0.422	0.458	0.394	0.385
6	0.323	0.496	0.525	0.475
7	0.51	0.695	0.57	0.509
8	0.566	0.74	0.557	0.597
9	0.604	0.747	0.621	0.597
10	0.694	0.847	0.663	0.695
11	0.77	0.905	0.742	0.773
12	0.852	0.948	0.782	0.803
13	0.851	0.94	0.809	0.868
14	0.904	0.973	0.855	0.892
15	0.935	0.982	0.903	0.921
16	0.944	0.99	0.906	0.94
17	0.959	0.982	0.915	0.932
18	0.959	0.991	0.954	0.942
19	0.989	0.992	0.963	0.944
20	0.375	0.532	0.5	0.462
21	0.667	0.666	0.67	0.693
22	0.684	0.728	0.754	0.735
23	0.752	0.675	0.786	0.799
24	0.782	0.827	0.797	0.817
25	0.844	0.887	0.848	0.8[illegible]8
26	0.779	0.527	0.736	0.771
27	0.75	0.629	0.686	0.821
28	0.826	0.544	0.781	0.784
29	0.753	0.694	0.723	0.722

Source: Defense Manpower Data Center

TABLE A-2

YEARLY FRACTIONS AT REENLISTMENT, FY 1977

YOS	Navy	Air Force	Army	Marine Corps
1	0.000395	0.00303	0.00141	0.00145
2	0.102	0.0016	0.0984	0.058
3	0.206	0.00518	0.756	0.25
4	0.663	0.664	0.33	0.777
5	0.105	0.17	0.145	0.236
6	0.294	0.062	0.239	0.285
7	0.131	0.353	0.246	0.245
8	0.25	0.431	0.2	0.209
9	0.264	0.119	0.2	0.383
10	0.293	0.101	0.5	0.494
11	0.159	0.318	0.244	0.317
12	0.199	0.568	0.276	0.398
13	0.142	0.142	0.217	0.31
14	0.133	0.057	0.211	0.297
15	0.123	0.15	0.191	0.271
16	0.128	0.657	0.14	0.334
17	0.0945	0.11	0.143	0.268
18	0.0797	0.0592	0.153	0.194
19	0.144	0.214	0.155	0.221
20	0.276	0.775	0.436	0.641
21	0.[illegible]26	0.45	0.332	0.471
22	0.182	0.229	0.[illegible]3	0.5
23	0.155	0.605	0.303	0.474
24	0.136	0.372	0.402	0.381
25	0.139	0.224	0.189	0.379
26	0.138	0.764	0.324	0.535
27	0.111	0.603	0.476	0.536
28	0.121	0.606	0.19	0.58
29	0.15	0.335	0.24	0.489

Source: Defense Manpower Data Center

TABLE A-3

YEARLY CONTINUATION RATES, FY 1977

YOS	Navy	Air Force	Army	Marine Corps
1	0.864	0.896	0.836	0.895
2	0.815	0.861	0.834	0.809
3	0.776	0.802	0.468	0.74
4	0.52	0.567	0.763	0.413
5	0.91	0.861	0.875	0.807
6	0.777	0.922	0.848	0.804
7	0.915	0.862	0.865	0.836
8	0.879	0.875	0.83	0.869
9	0.884	0.949	0.859	0.814
10	0.903	0.963	0.896	0.828
11	0.951	0.958	0.91	0.906
12	0.958	0.967	0.921	0.919
13	0.962	0.983	0.939	0.942
14	0.967	0.989	0.952	0.955
15	0.975	0.99	0.968	0.969
16	0.977	0.992	0.977	0.974
17	0.98	0.993	0.98	0.978
18	0.979	0.995	0.988	0.981
19	0.99	0.994	0.985	0.989
20	0.375	0.532	0.5	0.462
21	0.667	0.666	0.67	0.693
22	0.684	0.728	0.754	0.735
23	0.752	0.675	0.786	0.799
24	0.782	0.827	0.797	0.817
25	0.844	0.887	0.848	0.858
26	0.779	0.527	0.736	0.771
27	0.75	0.629	0.686	0.821
28	0.826	0.544	0.781	0.784
29	0.753	0.694	0.723	0.722

Source: Defense Manpower Data Center

APPENDIX B

RETENTION PREDICTIONS BY SERVICE

APPENDIX B

RETENTION PREDICTIONS BY SERVICE

Tables B-1 through B-12 contain retention predictions for each service for the two-tier, OSD, and PCMC retirement plans. Also provided in these tables are the steady-state force distributions by length of service.

TABLE B-1

RETENTION UNDER CURRENT SYSTEM AND
RETENTION PREDICTIONS FOR TWO-TIER PLAN, NAVY

	YOS Interval			
	0-5	6-10	11-20	21-30
Current System				
$\overline{CR}$	.778	.871	.964	.706
Cum	.284	.503	.692	.031
PDF	.558	.221	.198	.023
Two-Tier Plan				
Case 1				
$\overline{CR}$	.775	.865	.955	.718
Cum	.279	.485	.636	.037
PDF	.574	.221	.183	.023
Case 2				
$\overline{CR}$	.775	.865	.957	.718
Cum	.279	.486	.647	.037
PDF	.572	.220	.185	.024
Case 3				
$\overline{CR}$	.775	.866	.959	.718
Cum	.279	.486	.657	.037
PDF	.570	.219	.187	.024
Case 4				
$\overline{CR}$	.774	.864	.952	.714
Cum	.278	.480	.613	.034
PDF	.579	.221	.177	.023
Case 5				
$\overline{CR}$	.774	.864	.954	.714
Cum	.278	.480	.627	.034
PDF	.577	.220	.180	.023
Case 6				
$\overline{CR}$	.774	.864	.956	.714
Cum	.278	.480	.640	.034
PDF	.574	.219	.183	.024

TABLE B-2

RETENTION UNDER CURRENT SYSTEM AND RETENTION PREDICTIONS FOR OSD PLAN, NAVY

	YOS Interval			
	0-5	6-10	11-20	21-30
Current System				
$\overline{CR}$	.778	.871	.964	.706
Cum	.284	.503	.692	.031
PDF	.558	.221	.198	.023
OSD Plan Case 1				
$\overline{CR}$	.778	.896	.934	.769
Cum	.285	.576	.507	.073
PDF	.558	.227	.185	.030
Case 2				
$\overline{CR}$	.778	.896	.928	.769
Cum	.285	.576	.474	.073
PDF	.564	.230	.177	.029
Case 3				
$\overline{CR}$	.778	.896	.922	.769
Cum	.285	.576	.443	.073
PDF	.571	.233	.169	.027
Case 4				
$\overline{CR}$	.778	.898	.926	.780
Cum	.285	.583	.465	.083
PDF	.559	.229	.181	.031
Case 5				
$\overline{CR}$	.778	.898	.920	.780
Cum	.285	.583	.433	.083
PDF	.566	.232	.172	.030
Case 6				
$\overline{CR}$	.778	.898	.913	.780
Cum	.285	.583	.403	.083
PDF	.573	.235	.164	.028

TABLE B-3

RETENTION UNDER CURRENT SYSTEM AND
RETENTION PREDICTIONS FOR PCMC PLAN, NAVY

	YOS Interval			
	0-5	6-10	11-20	21-30
Current System				
$\overline{CR}$	.778	.871	.964	.706
Cum	.284	.503	.692	.031
PDF	.558	.221	.198	.023
PCMC Plan Case 1				
$\overline{CR}$	.781	.897	.913	.847
Cum	.291	.582	.403	.189
PDF	.553	.231	.180	.036
Case 2				
$\overline{CR}$	.781	.897	.906	.847
Cum	.291	.582	.372	.189
PDF	.561	.234	.171	.034
Case 3				
$\overline{CR}$	.781	.897	.898	847
Cum	.291	.582	.342	.189
PDF	.569	.238	.162	.032
Case 4				
$\overline{CR}$	.782	.900	.891	.867
Cum	.293	.590	.314	.240
PDF	.556	.235	.174	.035
Case 5				
$\overline{CR}$	.782	.900	.883	.867
Cum	.293	.590	.288	.240
PDF	.565	.239	.164	.033
Case 6				
$\overline{CR}$	.782	.900	.875	.867
Cum	.293	.590	.263	.240
PDF	.573	.242	.154	.030

TABLE B-4

RETENTION UNDER CURRENT SYSTEM AND PREDICTIONS FOR TWO-TIER PLAN, AIR FORCE

	YOS Interval			
	0-5	6-10	11-20	21-30
Current System				
$\overline{CR}$	.811	.893	.982	.661
Cum	.351	.568	.837	.016
PDF	.477	.229	.253	.042
Two-Tier Plan Case 1				
$\overline{CR}$	.807	.888	.977	.672
Cum	.343	.551	.796	.019
PDF	.490	.229	.238	.043
Case 2				
$\overline{CR}$	.807	.888	.980	.672
Cum	.343	.551	.816	.019
PDF	.487	.227	.242	.044
Case 3				
$\overline{CR}$	.807	.888	.982	.672
Cum	.343	.551	.837	.019
PDF	.484	.225	.246	.045
Case 4				
$\overline{CR}$	.806	.886	.975	.665
Cum	.341	.545	.777	.017
PDF	.496	.228	.234	.042
Case 5				
$\overline{CR}$	.806	.880	.978	.665
Cum	.341	.545	.804	.017
PDF	.492	.226	.239	.044
Case 6				
$\overline{CR}$	.806	.880	.982	.665
Cum	.341	.545	.832	.017
PDF	.488	.224	.243	.045

TABLE B-5

RETENTION UNDER CURRENT SYSTEM AND
PREDICTIONS FOR OSD PLAN, AIR FORCE

	YOS Interval 0-5	6-10	11-20	21-30
Current System				
$\overline{CR}$	.811	.893	.982	.661
Cum	.351	.568	.837	.016
PDF	.477	.229	.253	.042
OSD Plan Case 1				
$\overline{CR}$	.811	.916	.974	.720
Cum	.351	.644	.765	.370
PDF	,459	.228	.255	.058
Case 2				
$\overline{CR}$	.811	.916	.968	.720
Cum	.351	.644	.723	.370
PDF	.466	.231	.246	.056
Case 3				
$\overline{CR}$	.811	.916	.962	.720
Cum	.351	.644	.681	.037
PDF	.474	.235	.237	.054
Case 4				
$\overline{CR}$	.811	.917	.972	.726
Cum	.351	.649	.751	.041
PDF	.457	.227	.253.	.063
Case 5				
$\overline{CR}$	.811	.917	.966	.726
Cum	.351	.649	.707	.041
PDF	.465	.231	.243	.060
Case 6				
$\overline{CR}$	.811	.917	.960	.726
Cum	.351	.649	.644	.041
PDF	.473	.235	.234	.057

TABLE B-6

RETENTION UNDER CURRENT SYSTEM AND PREDICTIONS FOR PCMC PLAN, AIR FORCE

	YOS Interval			
	0-5	6-10	11-20	21-30
Current System				
$\overline{CR}$	.811	.893	.982	.661
Cum	.351	.568	.837	.016
PDF	.477	.229	.253	.042
PCMC Plan Case 1				
$\overline{CR}$	.815	.916	.962	.831
Cum	.360	.645	.677	.156
PDF	.448	.228	.249	.075
Case 2				
$\overline{CR}$	.815	.916	.955	.831
Cum	.360	.645	.633	.156
PDF	.457	.233	.239	.071
Case 3				
$\overline{CR}$	.815	.916	.949	.831
Cum	.360	.645	.591	.156
PDF	.466	.238	.229	.068
Case 4				
$\overline{CR}$	.816	.917	.947	.847
Cum	.363	.650	.579	.190
PDF	.449	.232	.245.	.075
Case 5				
$\overline{CR}$	.816	.917	.940	.847
Cum	.363	.650	.538	.190
PDF	.458	.237	.234	.071
Case 6				
$\overline{CR}$	.186	.917	.933	.847
Cum	.363	.650	.500	.190
PDF	.468	.242	.223	.068

TABLE B-7

RETENTION UNDER CURRENT SYSTEM AND PREDICTIONS FOR TWO-TIER PLAN, ARMY

	YOS Interval			
	0-5	6-10	11-20	21-30
Current System				
$\overline{CR}$	.757	.855	.951	.722
Cum	.249	.457	.605	.038
PDF	.591	.219	.164	.026
Two-Tier Plan Case 1				
$\overline{CR}$	.763	.848	.937	.736
Cum	.242	.438	.519	.047
PDF	.613	.218	.145	.024
Case 2				
$\overline{CR}$	.753	.848	.939	.736
Cum	.242	.438	.534	.047
PDF	.611	.217	.148	.025
Case 3				
$\overline{CR}$	.753	.848	.942	.736
Cum	.242	.438	.550	.047
PDF	.608	.216	.151	.025
Case 4				
$\overline{CR}$	.751	.845	.931	.731
Cum	.239	.432	.487	.043
PDF	.621	.218	.139	.023
Case 5				
$\overline{CR}$	.751	.845	.934	.731
Cum	.239	.432	.506	.043
PDF	.617	.217	.142	.023
Case 6				
$\overline{CR}$	.751	.845	.938	.731
Cum	.239	.432	.524	.043
PDF	.615	.215	.146	.024

TABLE B-8

RETENTION UNDER CURRENT SYSTEM AND PREDICTIONS FOR OSD PLAN, ARMY

	YOS Interval			
	0-5	6-10	11-20	21-30
Current System				
$\overline{CR}$	.757	.855	.951	.722
Cum	.249	.457	.605	.038
PDF	.591	.219	.164	.026
OSD Plan Case 1				
$\overline{CR}$	.760	.884	.910	.783
Cum	.254	.540	.389	.087
PDF	.590	.230	.151	.029
Case 2				
$\overline{CR}$	.760	.884	.901	.783
Cum	.254	.540	.353	.087
PDF	.599	.233	.142	.027
Case 3				
$\overline{CR}$	.760	.884	.893	.783
Cum	.254	.540	.321	.087
PDF	.607	.236	.133	.025
Case 4				
$\overline{CR}$	.761	.887	.898	.792
Cum	.255	.548	.342	.097
PDF	.592	.232	.147.	.029
Case 5				
$\overline{CR}$	.761	.887	.889	.792
Cum	.255	.548	.309	.097
PDF	.601	.236	.137	.026
Case 6				
$\overline{CR}$	.761	.887	.880	.792
Cum	.255	.548	.278	.097
PDF	.609	.239	.128	.024

TABLE B-9

RETENTION UNDER CURRENT SYSTEM AND PREDICTIONS FOR PCMC PLAN, ARMY

	YOS Interval			
	0-5	6-10	11-20	21-30
	Current System			
$\overline{CR}$	.757	.855	.951	.722
Cum	.249	.457	.605	.038
PDF	.591	.219	.164	.026
	PCMC Plan Case 1			
$\overline{CR}$	.763	.886	.888	.866
Cum	.259	.546	.304	.237
PDF	.583	.232	.151	.033
	Case 2			
$\overline{CR}$	.763	.886	.879	.866
Cum	.259	.546	.276	.237
PDF	.592	.236	.142	.031
	Case 3			
$\overline{CR}$	.763	.886	.871	.866
Cum	.259	.546	.250	.237
PDF	.600	.239	.133	.028
	Case 4			
$\overline{CR}$	.765	.889	.863	.883
Cum	.262	.556	.229	.287
PDF	.856	.237	.147.	.030
	Case 5			
$\overline{CR}$	.765	.889	.854	.883
Cum	.262	.556	.206	.287
PDF	.595	.241	.137	.027
	Case 6			
$\overline{CR}$	.765	.889	.845	.883
Cum	.262	.556	.185	.287
PDF	.604	.245	.127	.025

TABLE B-10

RETENTION UNDER CURRENT SYSTEM AND PREDICTIONS FOR TWO-TIER PLAN, MARINE CORPS

	YOS Interval			
	0-5	6-10	11-20	21-30
	Current System			
$\overline{CR}$	.740	.826	.943	.737
Cum	.221	.384	.556	.047
PDF	.680	.184	.118	.018
	Two-Tier Plan Case 1			
$\overline{CR}$	.736	.818	.923	.744
Cum	.216	.366	.448	.052
PDF	.703	.183	.099	.015
	Case 2			
$\overline{CR}$	.736	.818	.927	.744
Cum	.216	.366	.469	.052
PDF	.699	.182	.103	.016
	Case 3			
$\overline{CR}$	.736	.818	.932	.744
Cum	.216	.366.	4920	.052
PDF	.696	.181	.107	.017
	Case 4			
$\overline{CR}$	.735	.815	.914	.738
Cum	.214	.360	.406	.048
PDF	.710	.182	.094.	.014
	Case 5			
$\overline{CR}$	.735	.815	.920	.738
Cum	.214	.360	.433	.048
PDF	.703	.181	.098	.015
	Case 6			
$\overline{CR}$	.735	.815	.925	.738
Cum	.214	.360	.460	.048
PDF	.702	.180	.102	.016

TABLE B-11

RETENTION UNDER CURRENT SYSTEM AND
PREDICTIONS FOR OSD PLAN, MARINE CORPS

	YOS Interval			
	0-5	6-10	11-20	21-30
Current System				
$\overline{CR}$	.740	.826	.943	.737
Cum	.221	.384	.556	.047
PDF	.680	.184	.118	.018
OSD Plan Case 1				
$\overline{CR}$	.741	.841	.907	.801
Cum	.223	.422	.376	.109
PDF	.683	.189	.107	.021
Case 2				
$\overline{CR}$	.741	.841	.901	.801
Cum	.223	.422	.352	.109
PDF	.688	.191	.102	.020
Case 3				
$\overline{CR}$	.741	.841	.895	.801
Cum	.223	.422	.329	.109
PDF	.693	.192	.097	.019
Case 4				
$\overline{CR}$	.741	.846	.892	.812
Cum	.224	.432	.318	.124
PDF	.686	.191	.103	.021
Case 5				
$\overline{CR}$	.741	.846	.885	.812
Cum	.224	.432	.293	.124
PDF	.691	.193	.097	.019
Case 6				
$\overline{CR}$	.741	.846	.877	.812
Cum	.224	.432	.270	.124
PDF	.697	.194	.091	.018

TABLE B-12

RETENTION UNDER CURRENT SYSTEM AND PREDICTIONS FOR PCMC PLAN, MARINE CORPS

	YOS Interval			
	0-5	6-10	11-20	21-30
Current System				
$\overline{CR}$	.740	.826	.943	.737
Cum	.221	.384	.556	.047
PDF	.680	.184	.118	.018
PCMC Plan Case 1				
$\overline{CR}$	.745	.846	.894	.869
Cum	.229	.433	.327	.245
PDF	.669	.192	.115	.026
Case 2				
$\overline{CR}$	.745	.846	.887	.869
Cum	.229	.433	.301	.245
PDF	.675	.193	.108	.024
Case 3				
$\overline{CR}$	.745	.846	.879	.869
Cum	.229	.433	.276	.245
PDF	.682	.195	.101	.022
Case 4				
$\overline{CR}$	.746	.851	.870	.886
Cum	.231	.446	.248	.297
PDF	.670	.195	.112	.024
Case 5				
$\overline{CR}$	.746	.851	.861	.886
Cum	.231	.446	.224	.297
PDF	.677	.198	.104	.022
Case 6				
$\overline{CR}$	.746	.851	.852	.886
Cum	.231	.446	.201	.297
PDF	.685	.200	.095	.020