This chapter presents an overview of the theoretical and empirical models that underlie the results presented in Chapters Four and Five. In the discussion of the theoretical model, we summarize the military’s objectives, the factors influencing individual decisionmaking, and the organizational policies that are most relevant for our analysis of the military retirement system. In the discussion of the empirical model, we describe the assumptions and general methods we used to generate the results presented in the next two chapters. A more formal presentation is given in Asch and Warner (1994a).

THEORETICAL MODEL

Organizational Objectives

The military’s stated manpower goal is to attract and retain personnel in sufficient numbers to meet its grade and experience requirements. We call this the “macro” goal. Not so well recognized are several “micro” goals. First, personnel must be motivated to work hard and effectively. Since individual effort cannot be directly observed, compensation and personnel policies must be designed to provide individuals with the proper incentives to work hard and seek advancement. Second, the system must sort personnel effectively. That is, it must induce the proper person/rank/job matches, which requires retaining and promoting the more able to the higher ranks. Two implications follow. One is that low ability/effort individuals should be induced to leave. Another is that “climbing” (seeking ranks for which one is unqualified) and “slumming” (the converse of climbing) should also be discouraged.
Furthermore, given their hierarchical rank structures, the services want personnel to stay long enough to get a return on their training and experience, but not to stay too long. There must be enough turnover in the upper ranks to provide promotion opportunities for those in the lower ranks. Retention can be excessive, even among very able personnel. Consequently, the compensation system must be structured not only to provide the proper retention and effort incentives, but also to provide the incentive for personnel to separate when it is in the services’ best interest for them to do so.

Military personnel managers have a variety of policy tools at their discretion. Compensation policy instruments that we consider include: (1) the level of entry pay, (2) the sequencing of promotion and longevity increases thereafter (i.e., intergrade and intragrade pay spreads), (3) bonuses and other skill-specific pay, and (4) the retired pay system. Personnel policy levers include minimum standards for retention and promotion and use of up-or-out rules. How do individuals respond to these tools? We address this issue below, but first we discuss some of our assumptions about individual productivity.

**Individual Productivity**

Past research shows that military recruits vary with respect to both their ability to perform tasks within the military organization and their “tastes” for military life. Despite the substantial sums spent screening new recruits, the military cannot perfectly measure entrants’ true abilities. Rather, ability is revealed slowly over time. Nor can individuals’ tastes be observed. We can only discern from unfolding retention decisions that stayers have stronger tastes for service than do nonstayers.

We can also assume that the military organization has difficulty monitoring individuals’ work efforts. Although the military monitors work effort, it cannot do so directly or costlessly. While effort improves individual productivity, it also involves a cost—hard work. We assume that individuals do not like to exert work effort and would prefer to shirk if they could get away with it. In economists’ terms, the marginal disutility of effort is positive.

We also assume that ability has a bigger impact on individual productivity in the upper ranks than in the lower ranks. That is, an in-
Individual with a low mental aptitude and one with a high mental aptitude may perform low-level tasks equally well, but the high-aptitude person is likely to make a better colonel or master sergeant than the person with low aptitude. Since higher-ranking personnel control more of the organization’s resources and make decisions that have greater overall impact, it is important to have the most able personnel fill the upper slots. Individual work effort may also be more important at higher levels.¹

Individual Decisionmaking

Of the variety of policy tools military personnel managers have at their disposal, the optimal policies will depend on individual decisionmaking. Once we understand how people behave and what factors influence them, policymakers can design policies to influence behavior according to the organization’s goals.

Why do individuals join (or stay in) the military? We hypothesize that individuals join if they are better off doing so (in economic terms, if the expected utility from joining exceeds the expected utility from remaining in the civilian sector). The net payoff to joining depends partly on how long the individual remains in the military. Some join for only one tour, others for a 20-year career. We thus hypothesize that when deciding whether to join, individuals evaluate the payoffs to all the possible career paths that they might follow and weight each path by the probability that they will follow it. Career paths have dimensions of rank and years of service. Individuals with a lower taste for the military anticipate that they will not likely reenlist after an initial term. In contrast, individuals with stronger tastes for military life expect to serve longer, so they will place more weight on the payoffs associated with longer careers (e.g., retirement

¹As Willis and Rosen (1979) discuss, a complicating factor is that ability is not unidimensional. Ability traits that are important for success in the lower ranks (e.g., physical strength or the capacity to follow orders) may not be the same as those required at the upper ranks (e.g., analytical reasoning or leadership skills). Skills that make one a good captain may not make one a good colonel. If this is the case, performance in the lower ranks may not be a good forecast of one’s probable performance in the upper ranks, making selection for promotion more difficult. The problem is likely to be more severe in the officer ranks and it leads the services to stretch out the selection of officers for the senior ranks over time.
benefits). The benefits provided during the initial enlistment will dominate to a greater extent the enlistment decisions of low-taste personnel.

Aside from tastes, the decision to join depends in large part on the level of entry pay and its subsequent growth, with respect to both rank and longevity. Other important factors in the initial enlistment decision include the value of training received (especially its transferability to the civilian market) and educational benefits. An implication of our model is that ability has an ambiguous influence on the decision to join. If the more able have a higher expected payoff to joining (through, say, more rapid or more certain promotion or qualification for better educational benefits), they will be more likely to enlist. But the more able also have better civilian sector opportunities, which makes them less likely to join.

The decision to remain at each retention decision point thereafter is conceptually similar to the initial enlistment decision. Individuals are assumed to calculate the expected utility from remaining in the service by evaluating the payoffs to all possible future career paths and weighting the various paths by their probabilities. They will compare this utility with the utility from leaving immediately and stay if they expect to be better off. Again, we predict that high-taste individuals are more likely to stay, although more-able people may be more or less likely to stay than less-able people, depending on how ability is rewarded in the external market relative to the “internal” (service) market. The internal reward to ability depends in part on the extent to which the promotion system identifies and promotes the more able more rapidly and with higher probability. Even prior to the actual separation point, up-or-out rules induce separations of some personnel who know that they are likely to be affected by such rules.

Another factor that plays a role in retention decisions is the rate at which personnel discount future income. Research indicates that personnel have real discount rates in excess of 10 percent, as evidence from the drawdown separation program seems to confirm (see Warner and Pleeter [1995]). In our model, high discount rates serve to reduce the value of future pay relative to current pay and therefore cause individuals to place more weight on near-term pay in both their effort and retention decisions.
In addition to making retention decisions, personnel make choices about how hard to work. Individuals in our model supply effort in each grade and year of service up to the point where the extra (marginal) benefit of doing so equals the extra (marginal) cost. What factors affect effort? The answer is any factor that affects the marginal return or cost of effort. First and foremost in the military system is the return to promotion. Promotion to a higher rank provides a monetary reward and it may also yield psychological benefits. If future promotions depend on current performance, we predict that a higher monetary reward to future promotions should induce individuals to work harder in their current rank. The model also predicts that individuals will work harder in their current rank the more they value the status associated with higher rank. Similarly, individuals will work harder if doing so results in better future assignments, another nonpecuniary reward. Significantly, monetary rewards can come either through the active duty pay associated with higher rank or in the form of retirement benefits. Finally, individuals may also work harder in their current rank if there is an intragrade payoff that is contingent on effort. Performance bonuses or other nonmonetary rewards to top performers are hypothesized to spur effort.2

The military’s hierarchical rank structure and the structure of its promotion contests affect effort expended. Subject to individual qualifications, personnel are promoted through the lower ranks with virtual certainty based on time-in-grade or time-in-service requirements. But beyond the junior ranks promotions are determined in competitive “contests” or “tournaments” in which only a fraction of those seeking advancement are promoted.3 Competition at the up-

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2Two caveats regarding our modeling of effort are in order. First, we do not explicitly model the effect of a member’s effort on unit performance other than to assume that it has a positive effect. Thus, our model cannot tell us how much military output would rise when members’ effort supply rises. Second, we assume for simplicity that a member receives no satisfaction from his or her unit’s performance. Thus, our model does not account for the possibility that the member’s satisfaction with service life may increase (which would cause his or her retention probability to rise) when unit performance improves as a result of an increase in other members’ effort levels.

3Officer and enlisted promotion processes do differ somewhat. Officers are selected for promotion by selection boards and are promoted by entry year group. Failure to be selected within a specified YOS zone usually means the officer will never be promoted. Prior to the two highest grades, enlisted personnel are promoted on the basis
per ranks gets keener as a result of the declining fraction to be promoted and the increasing homogeneity of the pool of contestants. Some theoretical propositions follow. If the interrank pay spread is held constant, a declining probability of promotion tends to diminish work effort because personnel discount the reward to promotion by the probability that the reward will be received. If the probability of promotion is low, individuals will not expend much effort to be promoted without a sufficient reward for promotion. Therefore, to maintain effort incentives with declining promotion rates, increasing interrank pay differentials are required.

The rate at which promotion chances improve with effort is also predicted to affect effort expended. Individuals are likely to work harder when extra effort improves their promotion chances a lot than when it improves them only a little. When the probability of promotion is very high, as in the junior ranks, individuals need not exert a lot of effort to ensure that they surpass the promotion threshold, so that the effect of effort on the probability of promotion is small. Likewise, when the probability of promotion is low, a change in effort may not improve one’s promotion chance much. Therefore, marginal effort has little impact on the chance for promotion when the probability of promotion is either very high or very low. Extra effort has the most effect when the probability of promotion is around 50 percent.

In addition to the base promotion chance, the rate at which the likelihood of promotion improves with effort depends on the relative importance of random factors (“noise” or “luck”) in the promotion contest. Because promotion in the lower ranks is based on explicit criteria or standards, luck has only a small influence on promotion outcomes. Luck assumes a larger role as individuals progress through the upper ranks. Having the “right” assignment, working for

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4Historically, the promotion rates to grades O-4, O-5, and O-6 have been around 80 percent, 70 percent, and 50 percent, respectively. Promotion rates to these ranks have declined considerably during the drawdown.

5This statement is technically true only if the probability of promotion is less than .5. More generally, as discussed later in the text, the effect of the probability of promotion on effort depends on the level of the promotion probability.
the “right” mentor, etc., loom larger as one progresses to higher levels. The increasingly more important role of luck serves to blunt the relationship between effort and the likelihood of promotion and thereby discourages effort as individuals progress through the ranks, all else equal.

The relationship between effort and the likelihood of promotion is also related to the composition of the promotion pool. In the lower ranks there is likely to be a lot of variation, or heterogeneity, in the skills and qualifications of those available for promotion. When the promotion pool is heterogeneous, it is easy for an individual to bypass some of the others by working harder. As individuals progress through the ranks, the pool available for promotion to the next rank becomes more homogeneous. Bypassing one's competitors by working harder becomes increasingly difficult the more alike are the individuals in the promotion pool. The increasing homogeneity of the individuals in the promotion pool is predicted to further blunt the relationship between effort and the likelihood of promotion.

Tastes and personal discount rates are also predicted to influence effort in the model. Individuals with a high taste for the military are more likely to stay for future periods and are thus more likely to reap the benefits of harder work today. Therefore, individuals with a high taste will work harder. An important policy implication follows. Since first-termers have lower tastes than careerists on average, a pay raise targeted at the first-term force will not produce as much extra effort as a raise targeted at the career force. This result provides a rationale for skewing the pay table by longevity as well as by rank.

Finally, up-or-out rules are also hypothesized to induce effort by lowering the expected payoff to remaining in a lower grade (relative to advancement to a higher rank). Up-or-out rules can serve as a substitute for a direct increase in intrarank pay spreads.

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6Armies composed of draftees are difficult to motivate. The analysis here makes clear why. Contingent compensation cannot be used to motivate personnel who are not going to stay around long enough to collect it. Draft armies must be motivated by penalties associated with failure to perform (e.g., imprisonment and bad conduct discharges) rather than the promise of positive rewards for good performance.
Organizational Policies

We next discuss the policy implications of our analysis of individual decisionmaking. In this discussion, we highlight two key policies: (1) the sequencing of intergrade and intragrade pay, and (2) retired pay. We focus on these two tools because of their relevance to our analysis later of the military retirement system and MFERS. The relevance of a discussion of retired pay is obvious. But a discussion of the sequencing of intergrade and intragrade pay is also relevant because MFERS would need to be coupled with a pay raise so it could be implemented in a way to keep service members equally well off. Thus, a discussion of the structure of pay as a policy tool is germane.

Sequencing Intergrade and Intragrade Pay. Consider the model’s implications for how pay should be sequenced by grade and longevity. Because promotions through the junior ranks occur with virtual certainty based on skill acquisition and satisfaction of time-in-grade (TIG) and time-in-service (TIS) requirements, large intergrade increases to motivate effort are not needed. Luck plays a small role in the promotion process, so there is a less blunted relationship between effort and the likelihood of promotion in the lower grades.

But beyond the junior ranks, when personnel begin to reach the middle ranks in the second five years of service, promotions start to resemble a “tournament” with winners (promotees) and losers (nonpromotees). The military’s objective is to sharpen the competition and to induce the most qualified to reveal themselves in the promotion contest. Among other policies, sharper competition is induced through bigger intergrade pay spreads. Larger intergrade spreads motivate harder work in the quest for advancement and therefore discourage slumming (slacking). Larger spreads encourage the more able to remain in service and therefore help maintain the quality of the promotion pool. And by improving the talent pool and by inducing the more able to work harder, larger intergrade spreads prevent “climbing” (promotions of the less qualified).

As individuals progress toward the senior ranks, promotion rates fall. Absent any change in the structure of pay, declining promotion rates tend to discourage effort (when the probability of promotion is less than 50 percent). Clearly, interrank pay spreads need to rise with rank—that is, be skewed—to maintain effort. The tendency to reduce
effort is accentuated by several other factors. Two mentioned previously are the rising relative importance of “luck” in promotion outcomes and the increasing homogeneity of the promotion pool. Another is that as personnel progress through the ranks the number of remaining promotions (and therefore promotion payoffs) that can be earned decreases. Skewness is required for personnel to see a continuing reward to effort.

A final factor that leads to increased skewness is the fact that the number of participants in the promotion contest declines as individuals progress through the ranks. We show elsewhere (Asch and Warner [1994a]) that the marginal value of effort is smaller in contests that have fewer participants because in small contests people can pass fewer competitors by working harder. Since the scale of the contest diminishes at higher ranks, the interrank spreads should increase to maintain effort incentives.7

Other factors, though, reduce the required skewness. Obviously, the more value that individuals attach to the status and other nonpecuniaries associated with higher ranks, the smaller are the additional monetary rewards needed to motivate effort in the lower ranks. These nonpecuniary factors tend to rise with grade. A second factor is the transferability of training. The less that training received in the service improves outside employment opportunities, the smaller the in-service pay increases will need to be to maintain a given level of retention. The third factor is the correlation between tastes and ability. If the correlation is positive, so that the personnel who have stronger tastes for the military are also the more able, then less skewness is required to induce the more able to stay and seek the higher ranks.8

7Notice, though, that in the military there is still a sizable pool of competitors for promotion to the highest ranks, so pay spreads need not be as large here to motivate effort as in the top levels of corporations, where only a handful of competitors may be vying for promotion.

8An oft-cited factor that reduces the optimal degree of skewness is that the production of military “output” is team-oriented. Rosen (1992, pp. 234–235) writes that “if rewards are skewed too much, competitors may take steps to make others look bad rather than making themselves look good. Lack of cooperation and reduced cohesiveness can reduce the effectiveness of the overall team. Some happy medium must be struck here.” In our opinion, this argument is not particularly compelling in the military case because of the sheer numbers of individuals participating in the promo-
Intragrade pay should function like intergrade pay to motivate effort and induce the proper sorting within the organization. Intragrade pay should rise to some extent with experience to provide continuing skill acquisition and performance incentives (at least when coupled with minimum performance standards for retention). However, the intrarank longevity increases cannot be as large as the interrank increases or individuals will be encouraged to “slum.” At some point intrarank longevity increases should cease altogether so that those who are revealed to be unpromotable will be induced to leave voluntarily when it is in the services’ interest that they do so.9

Finally, personnel policies like up-or-out rules and minimum performance standards can play a positive role by: (1) increasing effort, and (2) inducing the voluntary departure of those who have low promotion chances. The extra turnover induced by up-or-out rules helps maintain promotion flows.

Retired Pay. What are the purposes of retired pay? Does retired pay have a unique role that cannot be accomplished with other forms of compensation or other policy tools? The lateral entry constraint means the military must access and train large numbers of entrants before identifying for advancement those who have the talent to perform the higher-level tasks in the organization. The military therefore wants to provide incentives for the most talented to stay and seek advancement and for others to leave after they find that they are unsuitable for the upper-level positions. That is, it must provide the proper incentives for personnel to self-sort. Salop and Salop (1976) were the first to recognize the use of “two-part” compensation schemes as a self-selection device. One such “two-part” scheme is a system of (1) active pay and (2) deferred retirement.

9The Report of the Seventh Quadrennial Review of Military Compensation (1992) had in fact identified and recommended correction of a number of inconsistencies between intrarank and interrank pay.
benefits that are paid only to those who achieve a certain rank and longevity. Delayed vesting of retired pay induces self-sorting because only those who think that they can achieve the requisite rank and longevity will stay early on while others will leave. Deferred retired pay is also predicted to motivate work effort, especially when combined with minimum performance standards for retention and up-or-out rules that prevent low-ranking personnel from staying long enough to collect retirement benefits.

The question arises why retirement benefits should be part of the self-sorting mechanism. After all, why not just pay a bonus to all who reach the requisite rank and years of service? The answer has to do with retired pay’s role as a separation incentive. At some point the military wants everyone, including the best personnel, to separate, even though they may still be very productive (i.e., their own productivity exceeds their pay). The longer individuals remain in the top positions, the slower will be the promotion rates for younger (and potentially equally able) personnel. Unless offset by changes in the structure of pay, reduced promotion opportunities in the junior ranks is predicted to discourage work effort in those ranks and will cause those junior personnel with the best external opportunities (i.e., the more able) to leave. Without the proper inducement, senior personnel may not want to leave voluntarily if their military pay exceeds their best private sector alternatives. Such is especially likely to be the case for those trained in military-specific skills.

Retired pay can be used to induce voluntary separation of senior personnel. For example, once personnel become vested in the immediate annuities provided by the current retirement system, they have a much reduced gain from staying and are therefore more willing to depart voluntarily. The retirement system therefore induces the separations needed to control the age or experience structure of the force and to maintain promotion flows for younger personnel.

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Because their gain to staying is smaller, turnover of enlisted personnel at YOS 20 is much higher than officer turnover. Most enlisted personnel have reached their terminal grades by YOS 20 and have fewer promotions and smaller in-grade longevity raises to look forward to. Beyond the 20-year mark, officers appear to postpone their separations until they fail selection to the next rank.
There is, of course, no reason why the separations required to maintain personnel flows could not be accomplished with other policy tools, like up-or-out rules. In fact, during the drawdown period, mandatory separations increased substantially with the reduction of high-year-of-tenure points. However, excessive reliance on involuntary separation to control the experience structure of the force can be bad for morale, and affect recruiting, retention, and work effort. These adverse effects might require the payment of a “regret premium” to compensate for the prospect of involuntary separation. In addition, personnel faced with the prospect of involuntary separation are likely to engage in activities aimed at getting the policy relaxed (e.g., complaining to personnel managers and writing to congressmen about the “unfairness” of the policy). Should their complaints prove successful, the services would be compelled to modify their forces in unproductive ways. After Milgrom (1988), we call these extra financial costs and productivity effects the organizational influence costs of mandatory separation. The organizational influence costs of the drawdown are apparent today, with discontent in the mid-ranks over the likelihood of mandatory separation. Separation pay is the “elixir” that eases termination from service and weakens potential criticisms about the capriciousness or arbitrariness of policy.

As mentioned in the introduction, critics of the current retirement system have charged that efficiency would be increased if the military shifted compensation away from retired pay and toward active duty pay, since members heavily discount future retired pay. However, such a policy would necessitate heavier reliance on involuntary separation to control the experience distribution of the force. Pressure would develop on the services to relax their policies and permit older personnel to stay until full retirement and superannuated forces might result. The adverse productivity effects of a much older force or the regret premium that might be required to maintain the current (younger) experience distribution, while hard to

11 Data from the reserves provide evidence that, in the absence of separation incentives, personnel would want to remain for much longer careers. Although vested after 20 creditable years of reserve service, reservists do not begin to receive benefits until age 60. Retention of reservists with 20 or more years of service is much higher than in the active force. In fact, there is some concern about superannuation in the reserve forces.
calculate, could be substantial. While clearly expensive, a system that provides voluntary separation incentives is likely to be cheaper.

The other purposes of retired pay are, of course, not unique. Motivating effort, improving retention, and inducing personnel to properly self-sort within the organization could be accomplished through an appropriately structured active duty pay table and through other personnel policies. The distinctive (if not unique) purpose for military retired pay is to induce voluntary separations at the appropriate points, thereby minimizing the influence costs that accompany involuntary separation.

**EMPIRICAL MODEL OVERVIEW**

To implement our theoretical model empirically we could have used two alternative approaches. One is to estimate the parameters of our model empirically using panel data on observed individual retention decisions and effort decisions (how much effort to expend) over the course of an individual’s career and then use the estimated model to forecast the effects of different policies. Such an approach is infeasible for two reasons. First, other than work by Gotz and McCall (1984) and more recent work by Daula and Moffitt (1995), attempts to estimate just the retention portion of the model have not borne much fruit. Second, except for some spotty information on military personnel performance, data on effort decisions do not exist.

We therefore took the second and more parsimonious approach—computer simulation of our theoretical model. To build this microsimulation model, we needed three types of parameter values: those relating to individual retention decisions, to individual effort decisions, and to the relationship between ability and compensation. For the retention-related parameters, in our model the individual’s stay/leave decision is basically characterized by three parameters: the mean and standard deviation of the initial taste distribution and the standard deviation of the distribution of random shocks that each individual faces in each grade and year of service. (See Asch and Warner [1994a] for a more formal description.) We experimented with alternative values of these parameters until the model replicated the historically observed aggregate retention patterns. To model personnel effort decisions empirically, we made assumptions about the relationships between effort supply and promotion and
about the cost to individuals of supplying effort. We then conducted sensitivity analyses to determine whether the model’s results were sensitive to changes in assumed parametric values. Finally, to implement empirically the ability sorting aspect of the model, we used data on military personnel aptitude scores, which are considered to be correlates of ability, as well as estimates made by previous studies of the effect of these scores on promotion probabilities. The discussion below provides more detail about how we constructed our empirical model, which we use to generate the results in Chapters Four and Five.

Retention and Force Structure

We calibrated the model using data from the Army enlisted force. To better estimate any cost savings associated with moving the current retirement system to MFERS, we also calibrated the model using data from the Navy enlisted force and from the Air Force enlisted force. In Chapter Four, we give results only for the Army because the results are qualitatively the same for the other services. However, we include the cost results from our analysis of the Navy and Air Force as well as the Army in our estimates of the cost savings associated with moving to MFERS.

The steady-state grade-by-YOS distribution of a given force will depend on many factors. The three crucial factors are the lengths of the initial enlistment and reenlistment contracts, promotion rates and timing, and retention rates. To implement the model empirically, we had to make simplifying assumptions about enlistment contracts. In reality, the almost infinite variety of enlistment and reenlistment contract lengths would be extremely difficult to model without individual-level data. Enlistees in the Army join for periods of two to four years, whereas Navy enlistees join for periods of three to six years. Once initial enlistments are completed, enlisted personnel can either extend their current enlistment contract for up to two years or reenlist for periods of three to six years. We simplify the model considerably by assuming that enlisted personnel initially enter for 4 years and then reenlist thereafter for four-year periods. However, we assume that once personnel reach YOS 20 and are eligible to retire, they make annual retention decisions thereafter. This assumption seems to be supported by the data—the continuation rates of those
not at their estimated time of separation (ETS) are much lower after YOS 20 than before, indicating less-rigid enforcement of enlistment contracts and more frequent retention decisionmaking beyond YOS 20.

We chose fiscal years 1987–1989 as representative for data on promotion rates and force structure. Promotion rates began to decline after 1989 as a result of the drawdown and therefore may not be representative of steady-state promotion opportunities.\textsuperscript{12} We used data from the Defense Manpower Data Center (DMDC) to compute promotion probabilities for enlisted personnel in each service. DMDC makes available data by fiscal year on end-strengths, promotions, and losses by grade and YOS. The promotion rate from a given grade-YOS cell was calculated as a proportion of personnel in the given grade-YOS cell at the end of each fiscal year that both stayed and was promoted during the next fiscal year. We then calculated the three-year (FY 1987–1989) average of these rates.

Finally, to calibrate the model, we built steady-state forces that mimic as closely as possible the force structure and retention patterns that prevailed in FY 1987–1989. The calibration takes place as follows. Consider personnel entering service during a given fiscal year. Between the time of entry and the end of the fiscal year both promotions and attrition occur. We used actual FY 1987–1989 data on enlisted personnel in each service to distribute new entrants by pay grade and YOS at the end of YOS 1 and to specify the YOS 1 loss rate. We then compute flows into the different grades in YOS 2 based on FY 1987–1989 promotion rates and the FY 1987–1989 average of enlisted non-ETS continuation rates for YOS 2. These flows are then adjusted to account for prior-service gains based on an average of FY 1987–1989 prior-service gain rates into YOS 2. We repeat the process for YOS 3.

Choice behavior begins to occur in YOS 4. Choice is based on the expected gain to staying. Conceptually, each member of the cohort that survives to YOS 4 has a gain to staying (or cost of leaving) that is based on: (1) the military pay table, the retirement system, and the

\textsuperscript{12}The exception is the Air Force. Because the Air Force started drawing down its forces in 1989, we chose fiscal years 1987 and 1988 as a representative data period for the Air Force.
Reforming the Military Retirement System

civilian pay stream that he or she faces; (2) future promotion probabilities and service high-year-of-tenure (HYT) policies; (3) the member’s taste for service; (4) the service member’s ability; and (5) the distribution of the random factor in retention decisions. As described in the discussion of the theoretical model, the gain to staying is a probabilistic weighting of the payoffs to staying to the various future YOS points and then separating, where the probability weights depend on the strength of tastes for service and therefore vary according to a taste factor and an ability factor. The cohort retention rate is derived as a weighted average of the probabilities of staying for different values of these factors. An efficient method for performing these calculations is described in Black, Moffitt, and Warner (1990).

The proportion of the YOS 4 cohort that stays (in a probabilistic sense) is then “aged” by YOS and grade over the next four years based on FY 1987–1989 promotion rates by grade and YOS and FY 1987–1989 non-ETS continuation rates. The fraction that survives to (each grade in) YOS 8 is then allowed to make another retention decision, which is again based on the factors identified above. The process repeats itself over the next four-year interval, and so forth.

Finally, the continuation rate in a given grade-YOS cell is set to zero if the YOS is equal to or greater than the grade’s HYT or up-or-out point. To make the model fit the observed FY 1987–1989 force better, in some cases the HYT is relaxed a year or two because significant numbers of personnel are observed who have YOS above the nominal HYT. For example, although the Army’s nominal HYT for E-8s is 24, in the FY 1987–1989 era there were significant numbers of E-8s in YOS 25 and YOS 26. Therefore, we set the E-8 HYT to be 26.

As mentioned above, the retention pattern and the resulting force structure predicted by the model are controlled by varying the three model parameters—the mean of the initial taste distribution (MUT hereafter), the standard deviation of this distribution (SDT hereafter), and the standard deviation of the random disturbance distribution (SDE hereafter). For example, increasing MUT raises retention at all YOS points (although early retention is most affected). Raising the variation in tastes, SDT, may increase or decrease retention, depending upon the levels of military and civilian pay. The YOS pattern of retention depends on the importance of random factors in the retention process relative to tastes. Random factors are less im-
portant the smaller SDE is. The smaller SDE is, the more retention tends to rise with YOS beyond the initial retention decision. In fact, if SDE were zero, then retention rates would jump to unity after the initial retention decision (as long as the gain to staying rises with YOS). That voluntary retention rates do not increase so sharply indicates that random factors are important.13

The first panel of Table 2 shows the actual grade-by-YOS of Army enlisted personnel for the FY 1987–1989 period. The distribution is virtually the same as the FY 1990 distribution. Based on an average of FY 1987–1989 continuation rates, the table shows what fraction of an entry cohort would survive to various years of service. About 34 percent would survive to YOS 5; 12 percent would survive to YOS 20 and become retirement-eligible. If the continuation rates were steady-state, the Army would get 5.31 man-years per accession on average. The average enlisted strength during this period was 647,187, and the Army would require 121,785 accessions per year to sustain this size force based on the FY 1987–1989 continuation rates.

An unsettled question is the rate at which personnel discount future dollars. Some previous research (Gilman [1976], Black [1983], Lawrence [1991]) suggests that personnel discount future dollars at fairly high rates. In their estimation of the dynamic retention model, Daula and Moffitt (1995) claim an econometric estimate of 9.9 percent. Using data on the drawdown choice of a lump sum versus an annuity separation benefit, Warner and Pleeter (1995) obtain an estimate of as high as 20 percent. We calibrated the model at a rate of 10 percent for all personnel.

The second panel of Table 2 shows the model parameters that yield simulated Army retention patterns and an Army force structure that was as close to the observed FY 1987–1989 force as we could get. Although the model fit is not exact, it is close: The force has virtually the same experience mix, the same survival to YOS 20, and a roughly similar grade distribution. Man-years per accession are slightly

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13The Army’s FY 1987–1989 average ETS retention rate at YOS 4 was 35 percent. At YOS 8 it was 64 percent and at YOS 12 it was 80 percent.
Table 2

Model Fits for Army Enlisted Personnel

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<tr>
<th>Grade-by-YOS Distribution</th>
<th>Survival to YOS</th>
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<td>Start of</td>
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<tr>
<td></td>
<td>YOS 1–4</td>
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<tr>
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</tr>
<tr>
<td>YOS 5–10</td>
<td>.7</td>
</tr>
<tr>
<td>YOS 11–20</td>
<td>.0</td>
</tr>
<tr>
<td>YOS 21–30</td>
<td>.0</td>
</tr>
<tr>
<td>Total</td>
<td>28.7</td>
</tr>
</tbody>
</table>

NOTES: Man-years per accession = 5.31, accessions based on force of 647,187 = 121,785.

II. Force Based on the Assumptions: Personal discount rate = 10 percent; MUT = 0; SDT = 3000; SDE = 40,000

<table>
<thead>
<tr>
<th>Grade-by-YOS Distribution</th>
<th>Survival to YOS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Start of</td>
</tr>
<tr>
<td></td>
<td>YOS 1–4</td>
</tr>
<tr>
<td>YOS 1–4</td>
<td>31.3</td>
</tr>
<tr>
<td>YOS 5–10</td>
<td>.0</td>
</tr>
<tr>
<td>YOS 11–20</td>
<td>.0</td>
</tr>
<tr>
<td>YOS 21–30</td>
<td>.0</td>
</tr>
<tr>
<td>Total</td>
<td>31.3</td>
</tr>
</tbody>
</table>

NOTES: Man-years per accession = 5.35, accessions based on force of 647,187 = 120,925.

higher in our simulated force and required accessions are slightly lower than in the actual force. This result arises from our assumption that all entrants enlist for four years. A significant proportion of Army entrants enlist for two or three years, which lowers the Army’s actual man-years per accession. Nevertheless, the point is not to perfectly predict the actual force, but to build a hypothetical force with characteristics as close as possible to the observed one with our simplifying assumptions and then study how that force would react to changes in compensation and personnel policy.

We find that we can also closely replicate the Navy force size and structure. For the Air Force, our calibration is less exact. The model overpredicts first-term retention and slightly underpredicts the flow of members who stay for 20 years of service. But adjusting the retention parameters to reduce first-term retention reduces the flow to 20-year retirement too much. The basic problem is that our assumption that retention decisions are made only every four years is too restric-
tive for the Air Force. Examination of non-ETS continuation rates suggests that Air Force enlisted members make retention decisions at times other than their formal ETS. Since no set of parameter values will exactly replicate the Air Force enlisted force, we chose a set of assumptions that would simulate the flow to the 20-year point relatively accurately. This set of assumptions should permit us to estimate fairly well the cost savings associated with moving the Air Force to MFERS.

A key test of the model’s plausibility is whether its predictions of the response to changes in compensation are consistent with available empirical evidence. To find out, we simulated the effects of (1) a one-multiple increase in the Selective Reenlistment Bonus (SRB) available at YOS 4, (2) a one-multiple increase at YOS 8, and (3) a 10-percent across-the-board increase in basic pay. The predictions generated by the model are within the range of estimates provided by econometric evidence. Evaluated on grounds of plausibility of the responsiveness of retention to changes in pay, the model seems well calibrated.

Computing Ability and Effort Supply

In addition to estimating the force structure implications of alternative compensation structures, the simulation model also estimates the implications for ability sorting and the average amount of effort supplied by the force. To incorporate the role of ability, we first posit a standard normal probability distribution of ability among the entry cohort. We then allow different ability types (captured by deviations from the mean ability level) to affect earnings in alternative employment (i.e., civilian earnings) and to affect the probability of promotion in each grade and YOS. We proxied these effects by using previous estimates of the relationships between Armed Forces Qualification Test (AFQT) scores and civilian earnings and between AFQT scores and promotion probabilities. Although AFQT score is not a direct measure of ability, it is thought to be a strong correlate of it.

14These previous estimates are obtained from Smith, Sylwester, and Villa (1991).
In calibrating the model, we had to make an assumption about the correlation between individuals' tastes for service and their ability. We calibrate the model assuming no correlation between tastes and ability.

Of particular interest from a policy standpoint is how compensation and personnel policy affect how well the organization is able to provide an incentive for the most able to stay and seek advancement. To measure the “ability sorting” effects of alternative retirement policies, we therefore compute the average ability of personnel by grade. Since the units in which ability is measured are set arbitrarily, the average E-1 ability level is set to zero. To measure ability sorting, we simply measure average E-9 ability—if average E-1 ability is zero, average E-9 ability tells us the degree to which the compensation and personnel systems induce high-ability individuals to stay and seek advancement to the upper grades.\(^\text{15}\) It should also be noted that since the units that ability is measured in are arbitrary, the changes in ability and ability sorting as a result of changes in policy will be of primary interest rather than the absolute levels of ability under each policy, per se.

Incorporating effort supply into the model is more complicated because, like the retention decision, the optimal effort supply decision for each individual is made in each grade and year of service and is both a forward-looking and backward-looking decision process. Furthermore, the decision will differ for individuals of different taste and ability types. To incorporate these factors, we first defined “individuals” in terms of standard deviations from the mean of the taste distribution and standard deviations from the mean of the ability distribution. We then calculated each “individual’s” optimal effort level in each grade and YOS interactively using Newton’s method.\(^\text{16}\)

As discussed earlier in this chapter, the optimal effort is given at the point where the marginal benefit of effort equals the marginal cost of

\(^{15}\)The choice of E-9 is arbitrary. We could also have measured ability sorting by measuring average E-7 or E-8 ability. Our results are qualitatively the same when we choose these grades instead.

\(^{16}\)For a generic description of how to use this method to numerically solve derivatives, see Press et al. (1992), p. 355.
Two factors most affect the marginal benefit: (1) the effect of effort on the probability of promotion, and (2) the return to being promoted (including the increment in basic pay and in status and rank in the current period and in future periods as a result of the promotion). The second factor is given by policy in our model. Thus, calibrating the model’s effort parameters required making assumptions about the effect of effort on the probability of promotion and about the marginal cost of effort.

Given our general lack of knowledge about what values these parameters should take, these assumptions will necessarily be arbitrary. Indeed, one of the reasons for using a simulation rather than an estimation approach is the lack of data on effort. Although the effort-related parameters are somewhat arbitrary, recall that our focus is on how optimal effort changes when policy changes and not on the absolute level of effort supplied. Thus, we want to set the parameters so that the results are not strongly affected by changes in their assumed values.

Consider our specification of the marginal cost of effort. Marginal cost is assumed to be linear in effort (i.e., marginal cost equals $10e_{it}$ where $e_{it}$ is effort in grade $i$ in period $t$). Raising and lowering the linear term by a factor of 10 (from 10 to 100 and 1, respectively) had no significant effect on the force structure and cost results shown in the next chapter.

We also had to make some assumptions about the effect of effort on promotion probabilities. In our theoretical model, the military evaluates the individuals seeking advancement and then selects some fraction for promotion. Although evaluation scores are subject to random factors, individuals can increase their scores in these contests and thus their probability of promotion by either being more able or by supplying more effort. The individual’s probability of promotion also depends on the ability and effort supply of all the other individuals vying for promotion.

Incorporating such contests into our empirical model at each grade and YOS for each individual’s ability and taste would add many lay-

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17More specifically, in the enlisted model we assume that the disutility (or cost) of effort is given as $5(e_{it})^2$, so that the marginal cost of effort equals $10e_{it}$. 
ers of complexity into our model. It would involve making specific assumptions about the military’s evaluation process and how effort and ability interact to affect an individual’s evaluation and thus one’s promotion chances. To minimize the number of assumptions we had to make, we first assumed that individual effort decisions have no effect on the Army’s aggregate promotion rate into each grade at each year of service. Given the large numbers of individuals who are competing for promotion at any given point, this assumption seems reasonable. However, we also assume that individuals view their own effort as having a positive effect on their individual chances of promotion and thus their marginal benefit of effort. After some experimentation, we set the effect of effort on the probability of promotion (denoted Beta_E) equal to .01. Increasing Beta_E to .1 increases the average optimal effort in the force but has little effect on retention patterns. Similarly, reducing this parameter by a factor of 10 (to .001) reduces average optimal effort but has little force structure or cost impact. The average ability level of the force also changes little as well.

We also note that although we can incorporate into our theoretical model the nonpecuniary rewards to increased effort such as better assignments, it is more difficult to incorporate them into our empirical model. We therefore ignore them. In addition, although our model can predict the effects of various policy variables on individual effort, it does not predict the implications of changes in individual effort for unit performance and military output. Presumably, higher individual effort will translate into better unit performance and increased military output, but our model does not specify how this occurs.

**Cost Analysis**

Once the model builds a steady-state force, it provides costs for that force. The two costs we focus on in the analyses below are the annual basic payroll cost and annual accrual cost of the retirement system. Until recently the DoD Actuary used a 2 percent real interest rate in its calculations, so we use a 2 percent real rate in our main analysis. The sensitivity of the cost results to changes in the assumed real interest rate is discussed in Chapter Four.
Estimating the MFERS Retirement Annuity

To calculate the expected retirement annuity a member would receive under MFERS, several assumptions had to made. First, we had to make assumptions about members’ contribution rates under the thrift savings plan. We assumed that the contribution rates for MFERS were the same as for FERS, holding age constant. These rates are shown in Table 3. The contribution rate for a given age interval equals the average fraction of basic pay an individual in that age range contributes to FERS times the fraction of those in the age range that contribute. Thus, the contribution rate is 3.25 percent for those between ages 20 and 29 and 5.75 percent for those between ages 50 and 59.

Of course, experience under MFERS may differ from the experience under FERS. A more complete analysis would model the member’s choice to participate in the thrift savings plan and the amount he or she would contribute. We ignore this facet of individual decision-making in our model. Instead, we conduct sensitivity analyses to test how sensitive our qualitative results are to different assumptions about member contribution rates. We find that the qualitative results are unchanged.

Under MFERS, members have several withdrawal options. First, they can choose to retire early and take reduced benefits under the basic plan. Second, under the thrift savings plan they can opt to take their benefits as an annuity, roll over their benefits into an IRA which they can begin withdrawing at age 59, or take a lump sum payment but face a penalty. We assume that members choose the option that yields the highest expected discounted present value.

<table>
<thead>
<tr>
<th>Age</th>
<th>Rate (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-29</td>
<td>3.25</td>
</tr>
<tr>
<td>30-39</td>
<td>4.0</td>
</tr>
<tr>
<td>40-49</td>
<td>4.5</td>
</tr>
<tr>
<td>50-59</td>
<td>5.75</td>
</tr>
</tbody>
</table>
To calculate a member’s accumulated contributions over his or her career, we assume that these contributions accumulate at the government real rate of interest (which we assume equals 2 percent). We assume an extremely conservative real return to thrift savings plan investments since 2 percent is the approximate return on Treasury bills. Long-term government bonds have somewhat higher real returns, and the real return in the stock market over the past 20 years has averaged about 9 percent. In calculating the accumulated contributions, we also assume that individuals progress through the military pay table at the average rate of promotion for each grade and year of service.

To incorporate the COLAs offered under the basic benefit plan, we assume an annual inflation rate of 3 percent. Finally, we assume that members who take the IRA withdrawal option under the thrift savings plan will have an IRA accumulation at a rate of interest equal to the government interest rate plus 2 percent (or 4 percent).

**Modeling the Transition to MFERS**

The above discussion addresses how we developed our steady-state empirical model. This model predicts behavior when all personnel are under a given compensation system. We also developed a model that predicts results for the transition to the new steady state to produce the results presented in Chapter Five. As discussed there, in considering the transition to the steady state, we consider two transition strategies. In the first case (the grandfathering case), new entrants are enrolled into the new compensation system but existing members are grandfathered into the current system. In the second case (the convert case), new entrants are enrolled automatically in the new system, but existing members are permitted to convert to the new system. For simplicity in constructing the transition model, we consider only retention and cost effects and ignore effort supply and ability sorting effects.  

18The model can be extended to consider effort supply and ability sorting effects. Although the model currently does not produce results relating to ability sorting, it accounts for the ability distribution for each cohort at each calendar year in computing the projected retention patterns for each year.
In the transition model, we project behavior by calendar year. For example, in the grandfathering case, the model projects behavior year after calendar year, as each entering cohort marches through its careers. Since we assume a maximum military career length of 30 years, it takes 30 years for all personnel to be under the new system. Because the transition model predicts retention outcomes in each year, it can be thought of as an inventory projection model.

To predict retention patterns in each year, we use the following general approach. First, we calculate the probability an individual in a given grade and year of service and with a given taste for military service stays in the service over the rest of his or her career under the current military compensation system and under MFERS. This probability is calculated using the methods used in the steady-state model. Second, we use these probabilities to predict the force size and structure for each future calendar year, accounting for the distribution of taste for military service. We assume that accessions vary each calendar year to ensure that the force size is constant from year to year. Third, we also use these probabilities to compute DoD’s basic pay costs and annual retirement costs. Under MFERS, the latter equals DoD’s contributions to the thrift savings plan as well as the retirement accrual charge for the basic plan.

To predict which members convert and which do not under case 2, we assume that a member with a given taste, grade, and year of service converts if the gain to staying under MFERS is greater than under the current plan (which, for simplicity, we assume is REDUX).

As a test of the consistency of the transition model with the steady-state model, we compared the results predicted for years 30 and beyond, when all members would be under the new system, with those produced by the steady-state model. Since accessions are allowed to vary from year to year in transition to the steady state, the new steady state may not be reached until some point well beyond year 30. Nonetheless, we find that the transition model’s predicted retention rates and costs for year 30 are extremely close to the steady-state predictions (within .5 percent). Thus, we have confidence that the transition and steady-state models are mutually consistent.