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Economic Factors in Reserve Attrition

Prior Service Individuals in the Army National Guard and Army Reserve

M. Susan Marquis, Sheila Nataraj Kirby

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This report analyzes the separation decisions of prior-service reservists in the Army Reserve and the Army National Guard, the two components that recruit over 60 percent of all Selected Reserve prior-service accessions. The authors examine the effects of military compensation on attrition among prior-service reservists. They also investigate the ways separation patterns differ depending on the personal characteristics of individuals. In successive sections, the report (1) reviews the conceptual model of attrition that guides the empirical work and specifies the hypotheses that are tested with the data; (2) discusses the data available for modeling attrition, and the methods of analysis; (3) describes the variation in length of service among prior-service enlistees as a function of selected characteristics; and (4) presents results from a multivariate analysis of attrition. The study suggests that the rate of military pay can significantly affect the length of service of prior-service personnel. However, demographic characteristics have a much larger influence on attrition than economic factors; targeted recruiting may be more effective in retaining personnel for longer terms than changing compensation policies.

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PREFACE

This report analyzes the attrition of Army Reserve and Army National Guard enlistees who have prior military service either on active duty or in reserve service. The analysis was conducted for the Office of the Assistant Secretary of Defense (Reserve Affairs) by the Defense Manpower Research Center, part of RAND's National Defense Research Institute, an OSD-sponsored Federally Funded Research and Development Center.

Most research on reserve manpower has focused on accession and attrition of individuals with no prior service. Yet, prior service individuals constitute a little over one-half of enlisted accessions into the Selected Reserve. Thus, understanding the accession and attrition behavior of prior service reservists is extremely important in developing effective reserve manpower strategies to achieve end-strength goals. Analyzing this behavior also has important implications for the optimal mix of prior-nonprior service personnel. Answers to this latter question depend on how long each type of personnel will stay in the reserve and how each responds to incentives designed to raise accession and retention.

This report examines the attrition behavior of prior service reservists in the Army Reserve and Army National Guard—over 60 percent of prior service enlisted accessions are to one of these two components. These components have also traditionally had relatively greater problems with attrition. Other papers will focus on accession of prior service individuals to these two components and accession and attrition in the other reserve components.

The analysis distinguishes between attrition to civilian life and transfers to military service (either active force or a reserve component). It looks at the factors influencing attrition, with particular emphasis on economic factors such as reserve and civilian pay, unemployment, and bonuses. The report should be useful to manpower policy planners responsible for reserve manning and for the allocation of recruiting resources to improve retention.

SUMMARY

Individuals with prior military experience constitute a little over one-half of all enlisted accessions into the Selected Reserve each year. The Army Reserve and Army National Guard enlist approximately 80,000 prior service individuals annually. Little is known, however, about how long such reservists stay once they enlist, or the factors influencing the separation decision. The importance of understanding the attrition behavior of prior service individuals is emphasized by the plans to place increased reliance on reserve units for increasingly complex missions. Current manpower requests call for increases in the size of the Selected Reserves, particularly the two Army components.

This study analyzes attrition of three fiscal year cohorts enlisting in the Army National Guard and Army Reserve during FY80–82. We follow these prior service individuals through the end of FY85. The cohort data were provided by the Defense Manpower Data Center and combine enlistment records, quarterly personnel records, and separation records for each enlistee in the three cohorts.

A primary objective of this research is to measure the effect of reserve compensation and other economic factors on attrition, and to identify high-risk individuals. The Sixth Quadrennial Review of Military Compensation (QRMC) is directed by Congress to review compensation for the Selected Reserve. Estimates of the effect of elements of the compensation package on reservists' behavior are an essential input for the QRMC recommendations.

The conceptual framework, borrowed from earlier work at RAND, look at the changes that might occur during the enlistment term to cause a decision to separate. These changes might involve changes in the relative net rewards from military and civilian life, changes in external circumstances, or changes in information regarding the attributes of the reserve job.

We use two survival analysis techniques to study the timing of attrition. The first is a descriptive technique that allows us to look at the distribution of attrition times and also how variations in a given characteristic affect the timing of separation. This reveals the gross effect of that characteristic and everything else that varies with it. To estimate the net effect of a characteristic controlling for other characteristics, we fit a multivariate model.

Defining attrition first requires the definition of a policy perspective. From the point of view of the total force, attrition to civilian life is the central problem; transfers to other components of the military are not

losses in this context because they remain productive and contributing members of the total force. In this report, we examine attrition to civilian life. Our definition of attrition includes all losses to the military, including separations at the completion of the enlistment term and at retirement as well as premature losses.

About 20 percent of prior service personnel joining the Army Reserve will leave within the first year and half will leave within the first two years. Attrition is lower among Guardsmen; about 40 percent leave within the first two years. This lower attrition among Guardsmen may be at least partly explained by the difference in the demographic composition of the accession cohorts. The Guard tends to enlist a higher proportion of older enlistees and those with more years of prior service; both of these characteristics tend to decrease attrition.

Although we focus on attrition to civilian life, from the viewpoint of the component, losses to other branches of the military rank equally with losses to civilian life, since all such separations lower readiness and raise the individual component's manpower requirements and costs. Therefore, it is interesting to examine the patterns of transfers from the two components to another reserve component or to the active force. Of those still "in service," i.e., not lost to civilian life after two years, 13 percent of the Army Reserve and 9 percent of Guard enlistees will have transferred. The proportions are much higher by the end of five years.

We find sizable differences in attrition for different demographic groups. Increasing years of military experience, age, and education are all associated with decreasing rates of attrition. For example, those with less than four years of military experience in the Guard have a two year attrition rate of 40 percent; those with ten or more years of prior experience at accession have only a 30 percent attrition rate. The difference is even more pronounced for the Army Reserve: 50 percent attrition for those with less than four years of service and 30 percent for those with ten or more years of prior service.

We fit a multivariate model to estimate the net effect of each variable on attrition. The explanatory variables include measures reflecting the return from reserve service relative to a civilian secondary job and demographic characteristics of the individual at accession.

Increases in military pay significantly reduce the rate of attrition at any point in time; for example, a 10 percent increase in average drill pay reduces attrition by about 4.5 percent in the Guard and by 9.5 percent in the Army Reserve. Both civilian pay and unemployment are significant and of the expected sign. Higher civilian pay increases attrition, higher unemployment reduces attrition, although both these effects are smaller than those associated with changes in reserve pay.

The results on the effects of bonuses on attrition are mixed. The affiliation bonus for prior active duty personnel is associated with lower attrition, but the effect is not statistically significant. The preponderance of evidence suggests that reenlistment bonuses do not significantly affect attrition.

Age and education remain strongly related to attrition in the multivariate analysis. Older individuals (age 36 or older) have attrition rates that are 30 to 40 percent lower than attrition rates for those age 25 or younger. Differences in education have large, significant effects on attrition, after controlling for other variables, with those without a high school degree having an attrition rate that is higher by 18 to 25 percent than that of high school graduates in the two components. Those with prior *active* service have a higher attrition rate than those who have previously served in the reserve. This may be partly due to differences in information and expectations: those with prior reserve service are more likely to know what the reserve job involves than those who had previously served only on active duty.

The results reported here on the attrition behavior of prior service personnel highlight the importance of economic factors in the reservist's separation decision. Our estimate of the elasticity of attrition with respect to changes in military pay and in local labor market conditions can assist QRMC in designing compensation reforms to obtain longer consecutive service and to reduce geographical shortages.

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I. INTRODUCTION

BACKGROUND

The Selected Reserve enlisted strength grew by 33 percent between 1980 and 1986 (Table 1.1). Most of this increase (approximately 65 percent) is accounted for by the increase in the Army National Guard and Army Reserve. Despite this dramatic growth, the components continue to report shortages of junior enlisted personnel, geographical and skill shortages of senior enlisted personnel, and shortages for larger units. These shortfalls are particularly critical in view of the Department of Defense (DoD) plans to maintain as small an active peacetime force as consistent with overall defense strategies, and to rely increasingly on reserve component units for increasingly complex missions (Department of Defense, 1987a). The DoD manpower requests for FY88–FY90 mirror this policy by holding the number of active component personnel at their current (or very slightly increased) levels while asking for increases in Selected Reserve strength (Table 1.2).

Meeting these current and future end-strength objectives may present some challenges to policymakers. First, the pool of eligible individuals from which the reserve may recruit is expected to shrink.

Table 1.1

SELECTED RESERVE ENLISTED END-STRENGTH BY COMPONENT

Component	FY80	FY82	FY84	FY86	Percent Increase from FY80 to FY86
Army National Guard	329,298	367,214	392,412	402,628	22.3
Army Reserve	169,165	208,617	222,188	253,070	49.6
Naval Reserve	70,010	75,674	98,187	116,640	66.6
Marine Corps Reserve	33,002	37,104	37,444	38,123	15.5
Air National Guard	84,382	88,140	92,178	99,231	17.6
Air Force Reserve	45,954	50,553	55,340	62,505	36.0
DoD Total	731,811	827,302	897,749	972,197	32.8

SOURCE: *Official Guard and Reserve Manpower Strength and Statistics-FY 1986 Summary*, Assistant Secretary of Defense (Reserve Affairs), RCS:DD-RA(M) 1147/1148.

Table 1.2

DEPARTMENT OF DEFENSE MANPOWER REQUEST, FY1988

Component	Selected Reserve Manpower (Strength in thousands)		
	FY88	FY89	FY90
Army National Guard	425.7	458.8	464.9
Army Reserve	319.4	330.4	339.0
Naval Reserve	149.5	157.4	161.7
Marine Corps Reserve	42.8	43.7	44.5
Air National Guard	113.4	116.7	117.7
Air Force Reserve	79.6	83.3	85.5
Total	1,157.3	1,190.3	1,213.4

SOURCE: Department of Defense, 1987a, p. II-4.

Reserve recruits are classified as nonprior service recruits—those without prior military training and experience—or as prior service recruits—individuals who have previously served in the active or reserve forces. The number of 18–24 year olds, who comprise the primary pool from which nonprior service recruits are drawn, is projected to fall by more than 10 percent between 1985 and 1990 (U.S. Department of Commerce, 1987). In addition, the eligible prior service pool is expected to decline due to the aging of Vietnam veterans and increased retention in the active forces (Department of Defense, 1985). Indeed, in FY86, the Army National Guard experienced difficulty in meeting its enlisted recruiting goal for both prior and nonprior service individuals and attributed it to the economic recovery that made recruiting more difficult (Department of Defense, 1987a). In the face of a declining pool of eligible individuals, the projected increase in reserve manpower will require that policymakers find ways to increase the rate of accession from the eligible pool or to increase retention of reservists. Thus, understanding the factors that determine the accession and attrition decisions of reservists is extremely important in developing effective reserve manning strategies to achieve the programmed increase in the reserve.

Most previous research on reserve manpower levels has focused on accession and attrition among nonprior service personnel. Yet, as Table 1.3 shows, prior service personnel constituted over one-half the number of enlisted accessions to the reserve from FY80–FY86. Indeed, for the Army Reserve, the proportion has been increasing over time.

As the recruiting environment changes, the most cost-effective mix of prior and nonprior service personnel to achieve strength objectives is an increasingly important question. Part of the answer depends on how long each type of personnel will stay in the reserve and how each responds to incentives designed to raise retention.

RESEARCH ISSUES

This report begins to address some of these issues by analyzing the separation decisions of prior service reservists in the Army Reserve and the Army National Guard.[1] We consider these two components because over 60 percent of prior service accessions are to one of the Army components.

A primary objective of this research is to determine what policies appear to be most effective in reducing attrition among prior service reservists. One policy tool available to planners is the compensation package. Questions we seek to answer about the compensation package include:

- What is the effect of an increase in reserve pay on attrition rates?
- How do special incentive bonuses influence attrition?

Answers to these questions are especially timely because the Sixth Quadrennial Review of Military Compensation (QRMC) is directed by Congress to review compensation for the Selected Reserve.

Table 1.3

PRIOR SERVICE ENLISTED ACCESSIONS AS A PROPORTION OF TOTAL RESERVE ENLISTED ACCESSIONS, FY80–FY86
(Percent)

Component	FY80	FY82	FY84	FY86
Army National Guard	48.2	46.0	46.0	46.5
Army Reserve	56.4	53.5	59.3	61.6
Naval Reserve	88.2	93.3	88.3	81.5
Marine Corps Reserve	46.0	48.0	69.7	39.8
Air National Guard	59.6	61.3	58.7	61.5
Air Force Reserve	78.5	73.2	75.9	76.3
DoD Selected Reserve	57.8	56.6	59.8	59.0

[1]A companion study currently under way models the decision by individuals with prior active or reserve service to enlist in a reserve unit.

Our research can also inform recruiting policies. Identifying the characteristics that distinguish individuals who are at high risk of attrition from those at low risk can potentially be useful in targeting recruiting resources and in enlistment screening. Thus, we will also investigate how separation patterns differ depending on the personal characteristics of the individual.

Our analytic approach differs from most earlier studies of attrition from the military in that we study the time until separation, rather than just the proportion who leave within a fixed period of time. We include in our measure of attrition or separation all losses to military service, including separation at the completion of the enlistment term and retirement, as well as premature losses.

PLAN OF THE REPORT

The next section briefly reviews the conceptual model of attrition that guides the empirical work and specifies the hypotheses that we will test with the data. Section III discusses the data available to us to model attrition and the methods of analysis. Section IV describes the variation in length of service among prior service enlistees as a function of selected characteristics. Results from a multivariate analysis of attrition are given in Sec. V. We conclude with some observations on the policy implications and uses of our results.

II. A CONCEPTUAL FRAMEWORK FOR ANALYSIS

Reserve service constitutes a part-time or secondary job for most reservists. Evidence from the 1986 Reserve Components Survey, administered in the first half of 1986 to all Selected Reserve components, shows that 79 percent of enlisted reservists in the higher pay grades are employed full-time in the civilian sector (Table 2.1).[1] Only about 5 percent are not in the civilian labor force, and another 5 percent are unemployed and searching for a job.

Enlistment and attrition decisions represent choices between reserve service and civilian secondary activities, such as a part-time civilian job or leisure activity. At accession, the individual chooses reserve service in preference to the alternative secondary activity. Attrition from reserve service indicates that the individual's preferences have changed and that he or she now perceives that well-being will be enhanced by choosing an alternative allocation of time.

In a series of recent papers, Grissmer and Kirby (1984, 1985, 1988) draw on the recent literature on labor market theory to develop in detail a theory of reserve attrition and to identify factors that may

Table 2.1

EMPLOYMENT STATUS OF RESERVISTS IN HIGHER PAY GRADES, 1985

Civilian Employment Status	Enlisted (Percent of Total)
Full-time job	79
Part-time job	8
Self-employed	3
Unemployed	5
Not in labor force	5

SOURCE: 1986 Reserve Components Member Survey, Question 3.

[1]We show the status for those in the higher pay grades, grades E4–E9, because they are more likely to be prior service individuals, the subjects of this study.

change an individual's valuation of reserve service relative to civilian alternatives. They identify three major types of changes that might occur during the enlistment term and hypothetically lead to separation:

- Changes in the relative rewards from military and civilian life.
- Changes involving major external circumstances of the individual's life, e.g., changes in marital status or geographic location.
- Changes involving new information about reserve service.[2]

Here, we briefly summarize the major hypotheses from their work that guide our selection of the explanatory variables used to model the attrition decision.

MILITARY AND CIVILIAN COMPENSATION

Military Pay Rates

Changing the level of military compensation is the major tool available to policymakers to attempt to influence the size and composition of the reserve forces. Other things equal, increases in military pay rates raise the expected return from military service relative to civilian alternatives. As a result, we expect that increases in military pay will encourage more eligible individuals to sign up for reserve service and lead fewer reservists to separate. Indeed, several studies have demonstrated that reserve accessions increase as military pay rates rise; this result is found both among individuals with prior military service (Shiells, 1986) and those without prior service (Rostker, 1974). A study analyzing the reenlistment decisions of Army National Guardsmen found that reenlistment rates tended to rise with net reserve income (Burright et al., 1982). An important objective of our research is to quantify the effect of changes in military pay on attrition among prior service reservists.

Special Incentive Bonuses

In addition to basic military pay, special bonuses may be offered that are targeted specifically to attracting and retaining reserve personnel with critical skills or in designated priority units in the Selected

[2]Attrition may also occur if the service is dissatisfied with the individual's performance. We consider here the individual's perspective because the data available for our analysis primarily measure characteristics that are likely to affect the individual's evaluation of the service rather than vice versa.

Reserve. While bonuses have long been available to policymakers to try to influence the composition of the active forces, it was only in the late 1970s that Congress authorized bonuses for the reserve forces (Department of Defense, 1987b). As with basic military pay, we expect that bonuses will increase accession and decrease attrition among individuals eligible to receive bonuses. Several previous studies support this hypothesis. Asch (1986) found that Navy veterans in skill classes that were eligible to receive bonuses for affiliating with the Naval Reserve did join the reserve at a higher rate than veterans ineligible for the bonus. An experiment designed to test the effects of reenlistment bonuses found that reenlistment rates among those offered a bonus were only slightly higher than among other reservists, although the difference was statistically significant. However, those in the experimental program who did reenlist committed for a longer term of service and served longer after reenlistment than those not in the experimental program (Grissmer et al., 1982; Grissmer and Hiller, 1983).

Two types of bonuses were offered during the period covered by our study (1980 through 1985) that may influence attrition decisions: affiliation bonuses for prior active duty personnel and reenlistment bonuses for reserve members. Affiliation bonuses were authorized in fiscal year 1981 for individuals joining the reserve who are serving or have served on active duty and who have a remaining military obligation.[3] If the remaining military obligation exceeds 18 months, one-half of the total bonus payment is paid at enlistment, and the other half is withheld until the fifth anniversary of enlistment into the military. Although this bonus was designed to encourage prior active duty personnel to affiliate with a reserve unit, the withheld payment may serve as a "completion bonus," providing an incentive to continue reserve service at least until the full bonus is received.

Reenlistment bonuses are offered to reserve members who have fewer than ten years of service and are in designated units or in designated specialties. To receive a bonus, the individual must extend enlistment or reenlist for a period of three or six years. We hypothesize that individuals who can anticipate that they will receive a bonus if they reenlist at their next anniversary will be more likely to complete their current term of service and to reenlist than otherwise similar individuals, so that attrition among bonus-eligible individuals will be lower at any given point. If the eligible individual does reenlist for the required term, he or she receives an immediate bonus payment and an additional payment for each year of completion. As with the

[3]The bonus was $25 per month of remaining obligation from FY81 through FY85 and was increased to $50 per month in FY86.

completion component of the affiliation bonus, we expect that this completion payment will provide an incentive for continued service.

Retirement Benefits

An individual's valuation of his or her participation in reserve service is also likely to be affected by anticipated future benefits from the military retirement system. The anticipated value of these benefits depends in part on whether the individual expects to have sufficient years of service for the benefits to be vested and how soon the individual expects to be able to reap the benefits. The more years of previous service the individual has at accession, the closer the reservist is to being vested in the military retirement system and so the higher the anticipated value of these future benefits. Older individuals are closer to retirement; thus, other things equal, the present value of the retirement benefits is higher for them than for younger reservists. We, therefore, expect attrition to decrease with age and with prior years of service.[4]

Civilian Economic Conditions

Increases in military pay raise the value of reserve service relative to civilian alternatives; similarly increases in civilian pay raise the attractiveness of the civilian options relative to reserve service. As civilian opportunities become more financially attractive, the more likely an individual will be to choose to leave reserve service.

Changes in the unemployment rate also reflect changes in civilian opportunities. At higher rates of unemployment, the more difficult it would be to find a secondary job in the civilian sector, and so the more likely it is that the reservist will opt for continued reserve service. That is, we hypothesize that attrition will fall as the civilian unemployment rate increases.

CHARACTERISTICS OF THE INDIVIDUAL AND CHANGES IN EXTERNAL CIRCUMSTANCES

A reevaluation of the benefits of reserve service and alternative civilian opportunities may stem from an external change that affects the relative value of a fixed set of alternatives (such as the changes

[4]Individuals with a long history of previous service have signaled a taste for military service that would also explain a negative relationship between years of service and attrition.

discussed above), or from a change in the set of alternatives facing an individual. Changes in the primary job, geographic relocation, and changes in family composition (such as marriage or the birth of a child), may alter the perceived set of options as well as altering the perceived benefits and costs of the alternatives. We expect attrition to be lower for individuals with job, geographic, and family stability than for individuals who experience change. Older individuals have more stability in terms of civilian jobs and family responsibilities than their younger counterparts, making continued reserve service easier for older reservists and, we expect, lowering attrition.[5]

Reservists with higher education have more job stability than the less educated, which would lead us to expect attrition to fall as educational attainment increases. However, given civilian economic conditions, education may also be related to the individual's perception of the probability of finding secondary job opportunities in the civilian sector or the perceived value of those opportunities. These latter effects would lead us to expect a positive relationship between education and attrition. On balance, then, the net effect of education can not be predicted *a priori*.

NEW INFORMATION ABOUT RESERVE SERVICE

The inflexible work schedule of the reserve job, typically requiring one weekend per month and two weeks during the summer, makes the reservist unusually vulnerable to schedule conflicts between reserve obligations and civilian employers. There is ample evidence from the 1986 Reserve Components Survey, mentioned above, that a considerable number of reservists face problems at work because of their reserve participation.

About 15 percent report that their supervisors had a "somewhat" or "very unfavorable" attitude toward their participation in the reserve. About 11 percent felt that their reserve status has been detrimental to their chance of success or promotion on their current civilian job. Obtaining leave for annual training or for extra reserve work is reported to be a fairly serious problem by a quarter of all reservists. Finally, there appear to be some real monetary costs to reserve participation; about half report losing overtime opportunities and wages as a result of the reserve job.

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[5]As we noted above, the present value of anticipated military retirement benefits increases with age, and this effect too leads to the hypothesis that age and attrition are negatively correlated.

For many reservists, an important component of the nonmonetary costs of reserve participation is the decrease in time available to spend with their families or leisure pursuits. Reservists responding to the 1986 Reserve Components Survey felt strongly that they did not spend sufficient time on family, leisure, or community activities; about one-quarter of the enlisted personnel encounter family problems with scheduling time for annual training and extra reserve work.

To some extent, these conflicts are "experience" attributes of the reserve job. The reservist learns about them only through actual experience. We expect that individuals who have previously served in the reserve are likely to be better informed about these attributes and their relative importance than those with prior active service. Therefore, we expect lower attrition among those with prior reserve service.

III. DATA AND METHODS OF ANALYSIS

THE DATA

The data for our analysis are a longitudinal history of reserve service for individuals with prior military experience in *either* the active or reserve forces[1] who joined the reserve during FY80 through FY82. The history file was developed by the Defense Manpower Data Center from the Reserve Components Common Personnel Data System. For each prior service individual joining the reserve during the study period the file contains information drawn from three types of records: the enlistment record; master file records through FY85 (the most current year for which master file records were available when these history files were constructed); and loss records.

The enlistment record contains the background characteristics of the individual at the time he or she joined reserve service. For our analysis, the important variables include: date of accession, age at accession, highest year of education, Armed Forces Qualifying Test (AFQT) scores, entering pay grade, years of previous military service, occupational specialty, home state, race, marital status, and sex.

The longitudinal file also contains data from the master file at annual anniversaries for reservists who are still serving. The master files are inventory files on all reservists updated every quarter. The files contain demographic characteristics and service information. Along with the transactions files that contain data on gains and losses, this file allows one to build a career history of the reservist, including subsequent reentry into the active or reserve forces, moves from one reserve component to another, and changes in pay grade. We use the annual pay grade and information about the individual's years of service to compute the military pay rate for the individual at accession, and at each anniversary date before attrition or until the end of the study period. The computation uses the reserve pay schedules for drill pay for a single drill; the pay rates for each fiscal year are deflated to January 1979 dollars.

For individuals who left the reserve, the personnel system's loss records are appended to the data file. The loss record provides information on the date of separation, allowing us to determine the length

[1]Similar files have also been prepared for individuals joining in FY83 and FY84. However, because preliminary analysis detected some unresolved data problems, we have omitted the more recent accession cohorts from this analysis.

of time the individual served. For these individuals, active duty enlistment records are also searched to determine if the individual subsequently joined the active force.

We have supplemented these data with information characterizing the civilian economic opportunities facing the individual—the unemployment rate and civilian wage rate in the individual's home state.[2] We obtained the unemployment rate in the home state for the quarter in which the individual joined the reserve and for every subsequent quarter through the study period. The data come from the Bureau of Labor Statistics monthly unemployment series; this series is based on data from Current Population Surveys. The hourly wage rate is based on hourly average earnings (excluding overtime) for production workers in manufacturing industries. These data are collected by the Bureau of Labor Statistics from a monthly survey of a sample of manufacturing establishments. Our quarterly wage measure is a simple average of the estimates for each month of the quarter and, as with the military pay rate, we deflate the civilian pay rate to January 1979 dollars.

One of the objectives of our research was to estimate the effect of bonuses on attrition. However, our files did not contain information regarding a reservist's eligibility for or receipt of such bonus. We obtained data on reserve units and military occupational specialty classes that were eligible for reenlistment bonuses; these were then linked with each individual reservist's[3] record. We make the following assumption: an individual anticipates eligibility for a reenlistment bonus at the next anniversary if he or she is currently in an eligible unit or specialty and has fewer than ten years of service. If the individual subsequently reenlists for a three or six year term in an eligible unit or specialty, we assume he receives a reenlistment bonus.

To estimate an individual's eligibility for an affiliation bonus, we make the following assumptions: we assume that an individual with previous active duty service enters the reserve with a remaining military obligation (and hence is eligible to receive an affiliation bonus) if he or she has fewer than six years of service and is younger than age 29. Because most individuals enter active duty at age 23 or younger, we assume that individuals who are older than 29 at the time they join the reserve will have satisfied any initial obligation remaining when

[2]The home state was obtained from the enlistment record. This information is not updated, at least on our files, for those who move.

[3]We were able to acquire data about skill classes that were eligible for bonuses only for the years FY81-FY85 and have had to assume that skill classes that were eligible in FY80 were those that we observed to be eligible in FY81. We have data on the units that were eligible only for FY80-FY82, and have had to assume that the units eligible in FY83-FY85 were those observed to be eligible in FY82. In fact, there were few changes in unit eligibility between FY81 and FY82.

they left active service as members of the Individual Ready Reserve and are, therefore, not eligible for the affiliation bonus. For our analysis of attrition, we are more concerned with the completion payment. We assume that an individual will be eligible to receive a completion payment from this bonus if he or she has fewer than five years of service at entry into the reserve. Unfortunately, more than 30 percent of the records for the Army reservists in our sample are missing information as to whether the individual's previous service was on active duty or reserve duty; for these cases, we have assumed that the individual does have active service and is, therefore, designated as bonus eligible if our other criteria for bonus designation are satisfied.[4]

THE ANALYSIS SAMPLE

This analysis focuses on attrition of prior service individuals who enlisted in Army Reserve or the Army National Guard during FY80 through FY82.[5] The number of prior service personnel joining the Army National Guard decreased slightly over the three year period (Table 3.1). However, accessions to the Army Reserve increased from about 32.5 thousand to about 38.5 thousand, an increase of over 18 percent. Both of the trends mirror the change in total accessions to the component over the period; as we saw earlier, prior service accessions as a share of total accessions remained quite stable.

The overall demographic composition of the prior service cohorts has remained remarkably stable over this time period.[6] Prior service accessions to the two components are generally of high quality: over 85 percent have completed high school and between 90 to 95 percent are ranked Category III and above in the Armed Forces Qualifying Test.[7] Indeed, between 35 to 40 percent are in Category I and II. The

[4]This decision was based on the fact that the criterion we established designates eligibility for the affiliation bonus only if the recruit has fewer than five years of service. However, the initial obligation for reserve service is usually much longer, generally six years. Consequently, individuals completing a first term of reserve service would not be included in our designation.

[5]We define an individual to have prior military experience if he or she attends regular drills and has at least six months of prior service. The services do designate whether an entering individual is a prior service individual, but because there are small differences between them in the designation, we have adopted this uniform definition to apply to this and future analyses of prior service personnel. Our designation differs from the service definition in only a small fraction of cases.

[6]By contrast, an earlier study found definite changes in the demographic composition of nonprior service accessions in the same three fiscal years (Grissmer and Kirby, 1988).

[7]Category I is given to individuals receiving scores of 93 or better on the Armed Forces Qualifying Test. Category II is a score between 65–92, Category III is a score between 31–64, and Category IV for individuals who score 30 or below.

Table 3.1

DEMOGRAPHIC COMPOSITION OF ARMY NATIONAL GUARD AND ARMY RESERVE

Variable	Army National Guard			Army Reserve		
	FY80	FY81	FY82	FY80	FY81	FY82
AFQT score						
Category I	7.0	6.5	6.1	8.8	8.3	9.5
Category II	35.0	34.7	34.4	28.8	27.7	26.4
Category III	53.8	54.1	54.8	53.6	53.0	52.6
Category IV	4.2	4.7	4.7	8.8	11.0	11.5
Education						
Less than high school	15.1	13.5	13.6	14.7	13.6	13.1
High school degree	66.7	68.1	69.4	68.2	70.4	73.9
Some college	12.1	12.2	11.0	10.4	9.0	7.2
College degree or more	6.1	6.2	6.0	6.7	7.0	5.8
Years of service at accession						
Less than 4	17.4	14.8	16.6	27.9	25.9	25.6
4–6	47.8	51.7	51.9	48.7	51.7	52.9
7–9	19.3	18.5	17.4	11.4	9.8	9.7
10–12	8.0	7.9	7.5	5.9	5.7	5.6
13 or more	7.5	7.1	6.6	6.1	6.9	6.2
Occupation group[a]						
Infantry	29.6	29.0	29.6	23.9	22.4	23.1
Electronic equipment repair	3.1	3.3	3.1	2.4	2.6	2.4
Communications/intelligence	8.6	8.4	8.2	8.0	8.0	8.6
Health care specialists	4.5	4.8	4.8	8.0	9.4	7.9
Other technical specialists	2.0	2.2	2.4	2.1	2.1	2.0
Functional support/administration	14.7	15.2	14.8	21.9	22.8	21.8
Electrical/mechanical equipment repair	18.7	18.5	18.8	13.7	13.4	14.0
Craftsmen	3.8	3.9	3.5	4.1	3.9	3.9
Service/supply handlers	14.2	14.1	14.4	14.8	14.0	14.9
Not occupationally qualified[b]	0.9	0.6	0.4	0.9	1.4	1.3
Age						
Less than 26	31.7	28.8	29.4	50.7	52.1	52.5
26–30	28.4	27.9	26.6	22.7	22.0	21.1
31–35	23.0	25.4	25.5	15.7	15.2	15.4
36 or older	16.9	17.9	18.5	10.9	10.7	11.0
Race						
Black	15.3	16.1	16.6	28.7	29.2	29.5
Not black	84.7	83.9	83.4	71.3	70.8	70.5

Table 3.1—continued

Variable	Army National Guard			Army Reserve		
	FY80	FY81	FY82	FY80	FY81	FY82
Sex						
Female	3.9	4.4	4.2	7.7	9.6	11.2
Male	96.1	95.6	95.8	92.3	90.4	88.8
Marital status						
Single	33.3	33.6	35.5	48.8	51.0	61.3
Married	66.7	66.4	66.5	51.2	49.0	38.7
Region						
Northeast	17.0	17.1	18.1	20.6	20.7	19.9
Midwest	25.6	25.1	24.8	25.3	26.3	27.4
South	38.8	37.9	36.3	35.4	35.2	35.5
West	18.6	19.9	20.8	18.7	17.1	17.2
Number of cases	43,716	42,012	41,913	32,425	35,079	38,436

[a]DoD 1-digit code.

[b]Also includes those in undesignated occupations, students, patients, and prisoners.

Army Guard recruits appear to have more years of education and higher aptitude test scores.

In both components, most prior service accessions have six or fewer years of prior service, indicating that they have probably completed only one term of service. Guard recruits tend to have more years of prior military experience. This is not surprising because Guard recruits are also older; a little over 40 percent are age 30 years or older. Almost a third enter the Guard with seven or more years of prior service; the corresponding figure for the Army Reserve is about 22 percent. Differences in the distribution of recruits by occupation reflect the differences in the primary missions of the two components. The Guard has a higher proportion of infantrymen and electrical/mechanical equipment repairmen; the Reserve has a greater proportion of those in administrative or support functions.

The Army National Guard enlists small proportions of females (4 percent) and blacks (16 percent), as compared with the Army Reserve (approximately 10 percent and 29 percent, respectively). A higher proportion of Guard enlistees are married (almost two-thirds); this is not surprising, given that they are somewhat older than those joining the Reserves. Well over a third of accessions to both components come from the South; another 25 percent come from the Midwest.

We selected a 10 percent sample from each of the cohorts to use in our analysis of the influence of economic and demographic factors on the attrition decision. To ensure that our sample mirrored the demographic composition of all recruits, we selected the sample by stratifying each cohort by the characteristics shown in Table 3.1, and then selecting a 10 percent random sample from each stratum. Our procedure was to order the observations on the basis of the values of the demographic characteristics, to group the ordered observations into clusters of ten, and to select the *n*th observation from each group, where *n* was a randomly selected number. Our analysis sample consists of 10,197 Army Reservists from the three cohorts, and 12,301 National Guardsmen.

DEFINING ATTRITION

One cannot define or measure attrition without first delineating the policy perspective. Thus, there are several measures of attrition because the definition of a "loss" depends on the perspective one adopts. When a reservist leaves his or her unit, the loss to that particular unit must be replaced. However, from the point of view of a reserve component, a transfer from one unit of the component to another does not reduce component end-strength and so would not be a loss to the component. Similarly, a transfer from one reserve component to another or a transfer from the reserves to the active force represents a loss to the component, but is not a loss to the total force. Here, we adopt the total force perspective; transfers from one reserve component to another or from the reserve to active duty are not real losses in this sense.[8] The analysis, therefore, focuses on losses to civilian life, although we present data in the next section on the nature and magnitude of these transitions from one component to another. We include individuals who transfer to the Individual Ready Reserve or to Retired Reserve as losses to the total force.

We define a separation in the following way. Beginning with the first anniversary date, we look to see if a master file record was found for the individual. If we find a year in which the master file record is absent, we search to see if the individual joined the active force during

[8]This is somewhat inconsistent with the way the enlistment cohort files were constructed. Any individual enlisting in the Army Reserve or Army National Guard during the period FY80–FY82 is counted as a gain, using the definition of the services, although some of these individuals may simply have transferred or moved during a given year. In this study, we are more interested in losses to civilian life and have, therefore, chosen to exclude from our attrition measure those transferring within the reserve or to the active force during a given year.

the year. If not, a separation is said to have occurred, and the loss record is used to determine the date of the separation. Similarly, if a master file record indicates that the individual is on retired status, standby reserve, or Individual Ready Reserve, the individual is considered a loss to the military and the loss record is used to assign a separation date. If the master file records indicate that the individual was serving in the Selected Reserve on adjacent anniversary dates or if an active duty enlistment record is found for the year, we treat this as a year of continuous reserve service. Thus, survival in this context means continuous service in the military from year to year. If there is a break in service (say, the individual leaves in January 1982 after completing his first term of enlistment, and later returns in, say, May 1983), he is counted as a loss by our definition. Temporary periods between anniversary dates during which the individual is not affiliated with a reserve unit are ignored in our definition of losses. For example, such temporary periods may occur during geographic relocations while the individual seeks to affiliate with a new unit.

METHODS OF ANALYSIS

Traditionally, studies of reserve attrition (Grissmer and Kirby, 1984, 1985, 1988) have modelled attrition behavior by examining the proportion who leave the service within a fixed period of time. These previous studies focused on attrition by nonprior reservists. For these reservists, there are natural time intervals to examine the attrition rate such as during and after training. However, for prior service reservists, there are no such natural time periods, except perhaps at the end of the enlisted term of service. If one looks at the probability of separation during the first year, for example, information is lost because reservists who separate after one month are treated the same as those who serve for twelve months. However, the full year of service is clearly more valuable to the reserve. Therefore, we chose to study how much time is served before separation rather than the probability of separation during a fixed period. Analysis of time is called survival analysis or duration analysis.

A distinguishing feature of our data, and most time-to-event data, is that the event may not have occurred at the time of analysis. In our case, we do not have loss dates for reservists who were still in military service at the end of FY85. These data are "right-censored"; we know only how long these individuals served through FY85 and that loss has not yet occurred. Special techniques have been developed to handle censored data and we use two of them in our study.

Three related functions are used in survival analysis to describe the distribution of time until the event of interest (i.e., attrition) occurs: (1) The survival function, $F(t)$, is the probability that an individual is still in military service at time t, where t is the number of months that have elapsed since the individual joined the reserve. This can also be viewed as the proportion of a cohort of prior service reservists that will remain in service at time t. Our estimate of the proportion who will leave by time t is then given by $1 - F(t)$. (2) The probability density function is given by $f(t) = -dF(t)/dt$. It gives the instantaneous rate of attrition at time t for all prior service reservists. (3) The hazard function, $h(t) = f(t)/F(t)$, is the instantaneous rate of attrition at time t for those who are still in service at time t. We will term this the attrition rate or loss rate.

We use two survival analysis techniques to study when attrition occurs. The first, called the Kaplan-Meier estimator, is a descriptive technique that allows us to look at the distribution of attrition times. The Kaplan-Meier estimator, often referred to as a life-table estimator, is a nonparametric estimator that makes no assumptions about the distribution of the survival function but corrects for sample losses due to censored observations prior to time t. If we let $n_{(j)}$ be the number of reservists in service at the start of time j and $d(j)$ be the number who leave in the period, then the attrition rate at time j, $h(j)$ is given by $h(j) = d(j)/n(j)$. Then the survival function can be estimated as:

$$F(t) = \Pi(1 - h(j)) \ ,$$

where the product runs from the initial period to $t - 1$ (Kalbfleisch and Prentice, 1980; Cox and Oakes, 1984). We also use the Kaplan-Meier estimator to see how the timing of attrition varies across reservists who have different demographic characteristics.

The Kaplan-Meier estimators for different subgroups allow us to see how variations in one characteristic at a time affect the timing of separation. This reveals the gross effect of that characteristic and everything else that varies with it. For example, because years of prior experience increase with the age of the reservist, Kaplan-Meier estimators for reservists of differing age also include any effect of years of service on the timing of separation. To estimate the net effect of a characteristic, controlling for other characteristics, we fit a Cox proportional hazards model (Cox, 1972). This model assumes that the attrition rate function for an individual with characteristics given by x is:

$$h(t;x) = g(x)h_0(t) \ ,$$

where $h_0(t)$ is an underlying attrition rate function and $g(x)$ is a function of the characteristics.

In the Cox proportional hazards model, no assumptions are made about the underlying model for the attrition rate, $h_0(t)$; it is completely arbitrary and unspecified. We adopt the Cox model precisely because it is less stringent in its assumptions than some of the alternative hazards specifications. We are not so much interested in describing the shape of the function as in how differences in characteristics shift the hazard function. In the Cox model, one assumes that the effect of an increase in a given characteristic, say x, is to multiply the attrition rate by a constant factor $g(x)$, so that the attrition rates for groups of individuals with different levels of x are proportional. A common form for $g(x)$, since the attrition rate must be greater than zero, is $g(x) = \exp(bx)$, where b denotes the regression coefficients to be estimated. Here, the multiplicative effect on the attrition rate of an increase in x is given by $\exp(b)$.

A concrete example may help to illustrate this point. Assume we have a reference individual who we will characterize by $x = 0$; the attrition rate function for the reference individual is then the (unspecified) $h_0(t)$. A second individual is similar to the reference individual in all respects, except that the second recruit differs in one characteristic; for example, he receives an affiliation bonus ($x_1 = 1$). For the second individual, we have

$$h(t;x_1 = 1,x_2 \ldots . x_n) = \exp(b_1)h_0(t) \ ,$$

or

$$h(t;x_1 = 1,x_2 \ldots . x_n = 0)/h_0(t) = \exp(b_1) \ .$$

Thus, for example, if we estimate $\exp(b_1) = 0.94$, this indicates that at any point in time the probability of attrition among reservists who receive a bonus is 94 percent of the attrition among those not eligible for the bonus; we would interpret this hypothetical result as a 6 percent reduction in the rate of attrition due to the bonus.

IV. PATTERNS OF ATTRITION

TIMING OF ATTRITION

The Kaplan-Meier estimators of the attrition function for prior service personnel in the Army Reserve and the Army National Guard are depicted in Fig. 4.1. The horizontal axis shows the length of time elapsed in months since entering the reserve component. Each point on a curve indicates the cumulative proportion of reservists in the component who will leave military service by that time. For example, about 20 percent of prior service personnel joining the Army Reserve will leave within the first year, and half will leave within the first two years. Attrition is lower among reservists in the National Guard, a fact at least partly explained by the differences in the composition of accessions to the two components. The Guard enlists higher proportions of older enlistees and those with more years of prior military experience. Both of these groups tend to have lower attrition.

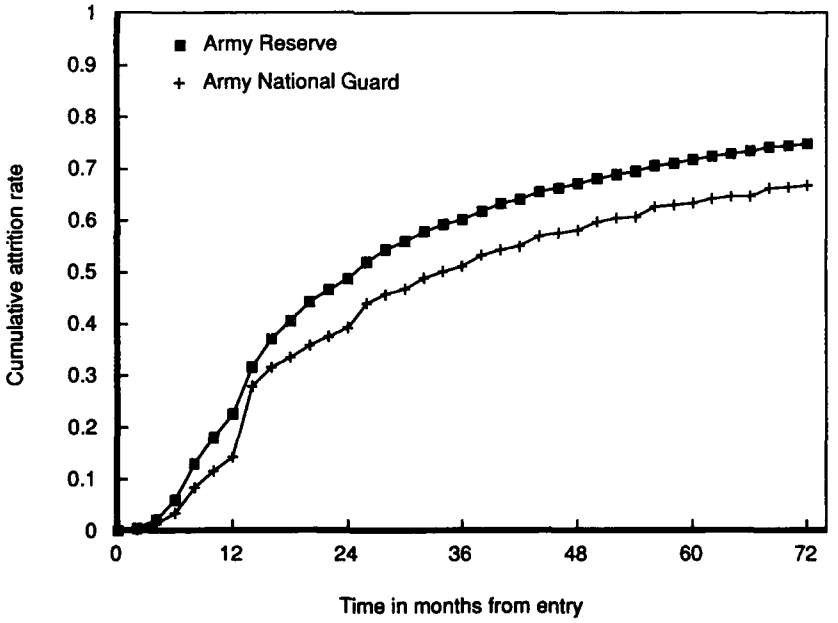

Fig. 4.1—Attrition from the Army National Guard and Army Reserve

In both reserve components, attrition rises steeply at 12 months after enlistment; most prior service accessions join up for one year and quite a few leave after their initial enlistment is completed. The peak in the attrition rate at 12 months is seen clearly in Fig. 4.2. The attrition rate (the instantaneous probability of attrition among those in service at the time) rises during the first year, peaks at 12 months, then declines. The decline reflects a decreased risk of attrition if the reservist remains in service beyond the initial one year obligation, though there are also small peaks at subsequent anniversary dates.

TRANSFERS

The attrition functions shown in Figs. 4.1 and 4.2 reflect the decision to leave military service. The specific reserve components realize additional losses, however, because some who stay in military service leave the entering component and join another reserve component or the active force. The transitions within military service are shown in

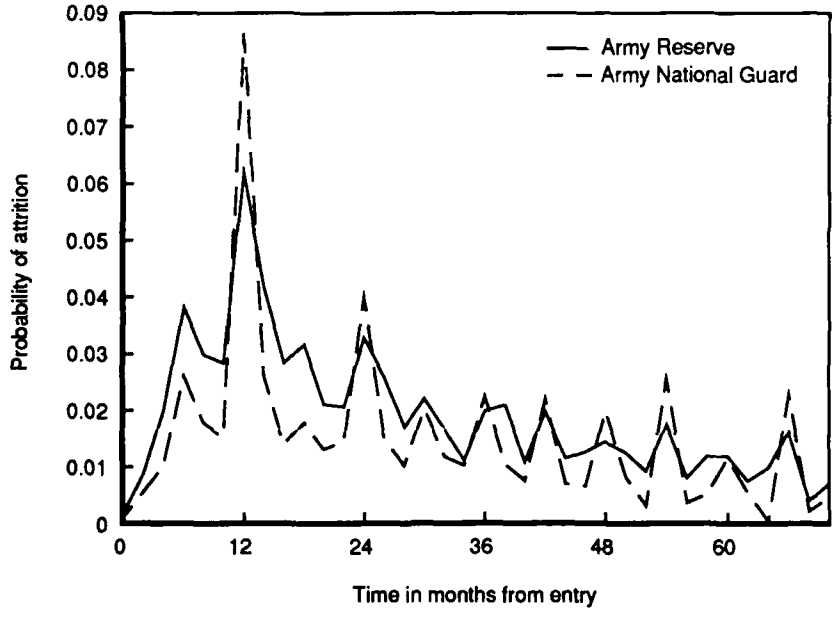

Fig. 4.2—Attrition rates for the Army National Guard and Army Reserve

Table 4.1. The table shows the military affiliation of those still remaining in military service after a given period since entry. For example, of those who enlisted in the Army Reserve and are still in service two years after enlistment, 87.2 percent remain in the Army Reserve, 7.5 percent have transferred either to the Army Guard (6.2 percent) or other reserve components, and another 5.3 percent have joined the active force. These represent 50 percent of the total enlistments—as we saw earlier (Fig. 4.1), about half of the Army Reserve personnel leave within the first two years. Most transitions are separations from the reserve to active duty service and transfers between the two Army Selected Reserve components; transfers from the Army Reserve components to other reserve components are rare.

We saw above that civilian attrition from the Army Reserve is slightly higher than from the Army National Guard. Losses from the Army Reserve to other military service are also greater than losses from the National Guard. Among those still in service after two years, 13 percent of the Army Reserve and 9 percent of Guard enlistees will have transferred to another reserve component or to the active force. Among those remaining in service at five years, 25 percent of Army Reserve accessions will have transferred elsewhere, whereas the

Table 4.1

AFFILIATION OF PERSONNEL STILL IN MILITARY SERVICE BY TIME SINCE ENTRY
(Percent)

Time Since Entry	Army Reserve	National Guard	Other Reserve	Active Force
Army Reserve accessions				
One year	92.5	3.6	0.7	3.2
Two years	87.2	6.2	1.3	5.3
Three years	83.5	7.8	2.2	6.5
Four years	80.0	9.5	3.0	7.5
Five years	75.4	11.3	4.0	9.3
National Guard accessions				
One year	1.6	95.1	1.3	2.0
Two years	3.2	91.1	2.5	3.2
Three years	4.5	88.3	3.3	3.9
Four years	5.6	85.4	4.1	4.8
Five years	6.7	82.3	4.5	6.6

corresponding figure for the Army National Guard is 18 percent. Thus, the difference between the two components in loss rates is accentuated if we take account of separations to other military service as well as civilian attrition. In addition, the Army Reserve loses more personnel to the Army National Guard than they gain. After two years, 6 percent of Army reservists will have transferred to the Army National Guard, whereas only 3 percent of those who entered the Guard transfer to the Reserve. In numbers of reservists, about 3900 members of the three accession cohorts of the National Guard transfer to the Army Reserve within the first two years, whereas almost 6400 Army Reservists in the three cohorts transfer to the National Guard.

ATTRITION DIFFERENCES BY DEMOGRAPHIC CHARACTERISTICS

Attrition differs markedly for different demographic groups, as is shown in Figs. 4.3–4.8. These graphs show the cumulative attrition

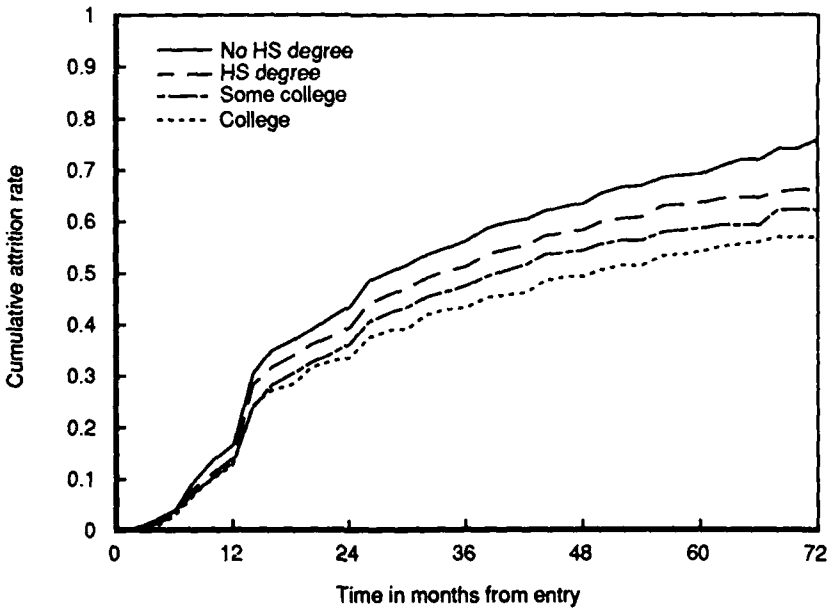

Fig. 4.3—Attrition from the National Guard by educational level

rate since enlistment for each group. We show the cumulative attrition rate rather than the hazard rate function because the former is smoother and thus easier to interpret.[1] The cumulative attrition rates are also a little easier to interpret for policymakers interested in examining what proportion of a group survives at different points in time. The higher the level of education, the lower is the rate of civilian attrition (Figs. 4.3–4.4). high school drop out of the National Guard within two years, but only 30 percent of those with a college education leave within two years (Fig. 4.3). The effect of education on attrition is even more striking in the Army Reserve (Fig. 4.4). Here the two year rate of attrition for those who have not completed high school is over 60 percent, but the attrition rate falls by half for those who have completed college.

We postulated in Sec. II that attrition will decrease with the number of years the individual had previously served in the military because both current pay and the present value of retirement benefits would be

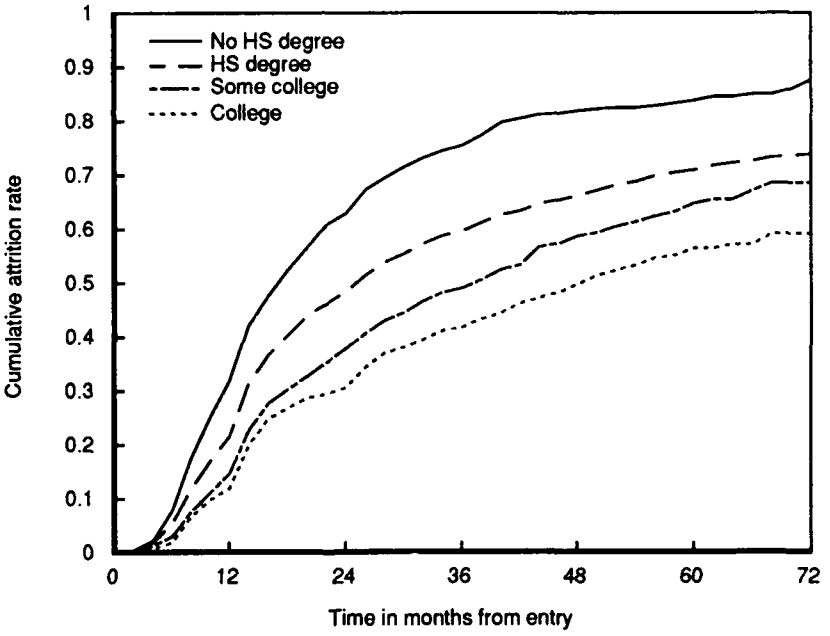

Fig. 4.4—Attrition from the Army Reserve by educational level

[1]The associated hazard functions are shown in the Appendix. We show the hazard function only for reservists with the lowest and highest value of the characteristic to make it easier to read the graph.

higher. Figures 4.5 and 4.6 show this to be the case. The two year rate of attrition among those with less than four years of previous military service is 40 percent in the National Guard and 50 percent in the Army Reserve whereas the rate is only about 30 percent for reservists in both reserve components who have ten or more years of experience for both components. About 45 percent of the reservists who have not completed

There are also sizable differences in attrition associated with the age of the reservist at accession (Figs. 4.7 and 4.8). For the Guard, the two year rate of attrition for persons under age 26 is 45 percent; for those age 36 and older it is only 30 percent. This discrepancy is even more pronounced in the Army Reserve; about 60 percent of those under age 26 leave within two years whereas the attrition rate among those 36 and older is only 25 percent. Older enlistees presumably have more stability in terms of civilian jobs and family responsibilities than younger persons. However, the age effect in Figs. 4.7 and 4.8 is at least

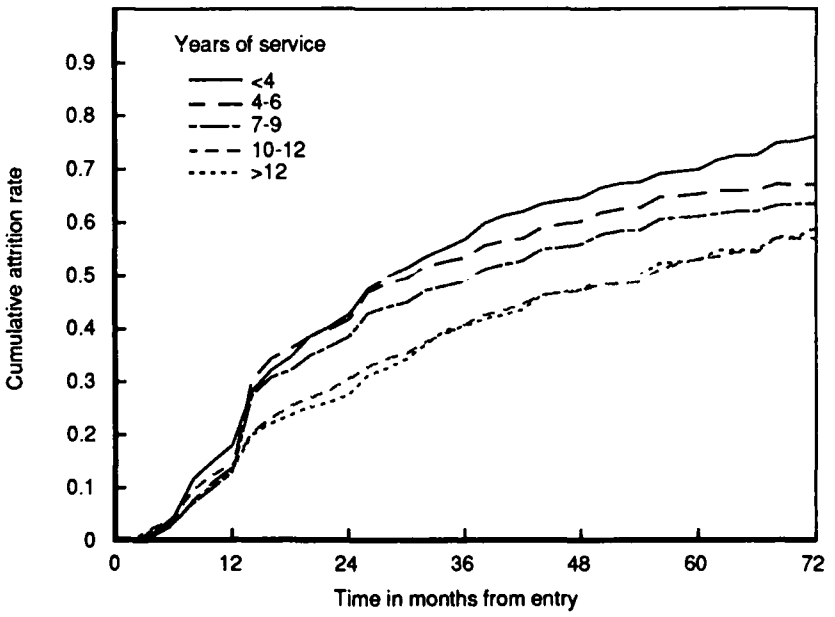

Fig. 4.5—Attrition from the National Guard by prior years of service

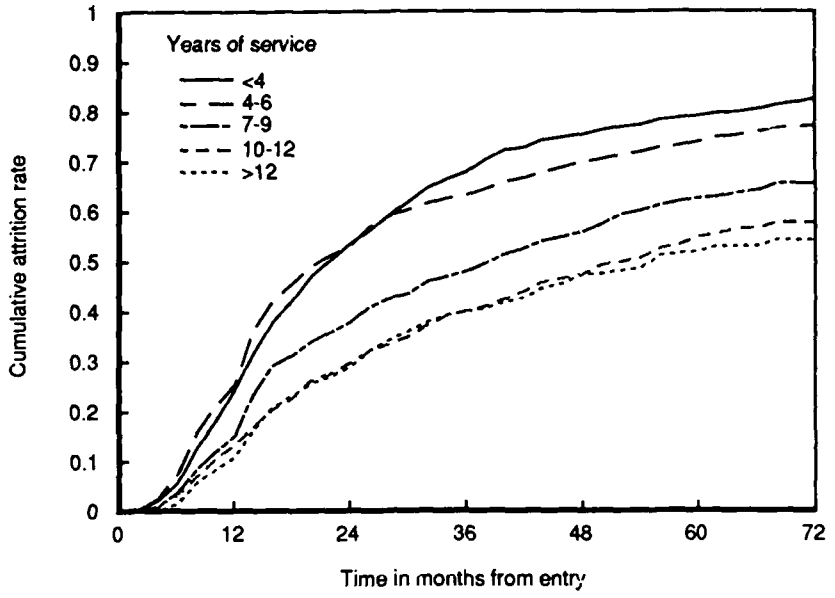

Fig. 4.6—Attrition from the Army Reserve by prior years of service

partly the result of the correlation between years of prior experience and age. The graphs displayed here present the total effect of a characteristic and everything correlated with that characteristic rather than the incremental or net effect of that variable alone, holding all other variables constant. The next section presents a multivariate model that estimates the net effect of each characteristic on attrition.

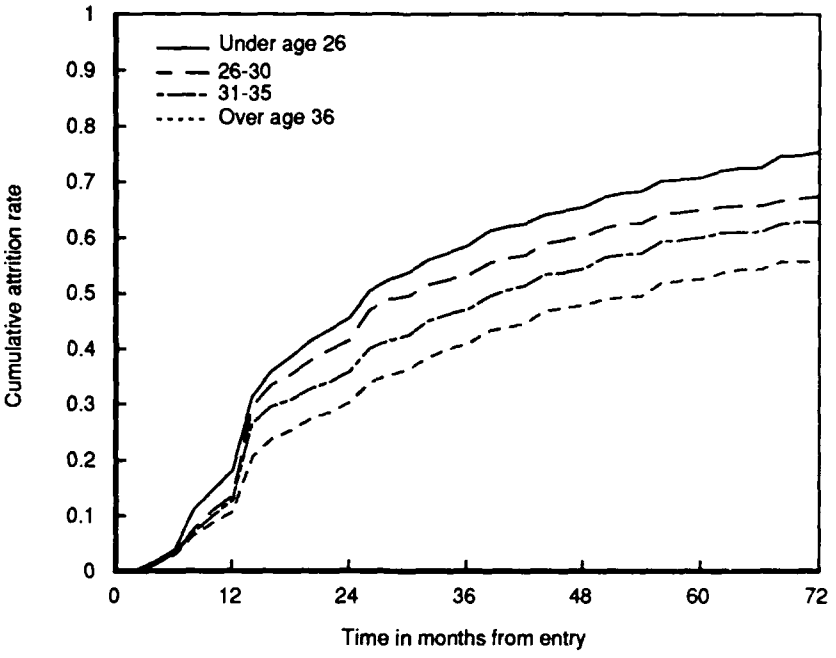

Fig. 4.7—Attrition from the National Guard by age

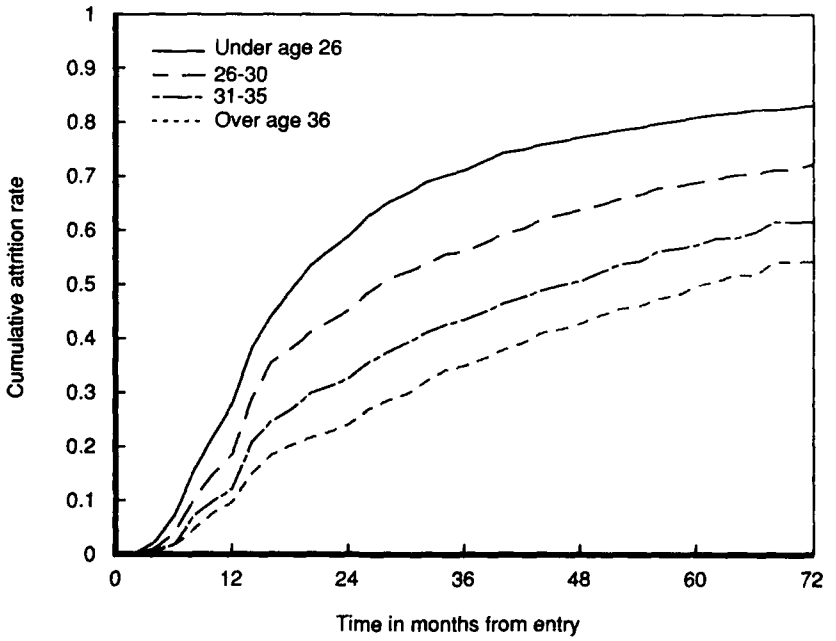

Fig. 4.8—Attrition from the Army Reserve by age

V. MULTIVARIATE ANALYSIS

INTRODUCTION TO THE MULTIVARIATE ANALYSIS

We fit a Cox proportional hazards model, described in Sec. III, to estimate the joint effect of the characteristics on attrition. There are two types of explanatory variables in our model: (1) baseline characteristics of the individual at the time of accession, including the recruit's age, prior military experience, and education, and (2) measures reflecting the return from reserve service versus a civilian secondary job, including reserve drill pay, reserve bonuses, the civilian wage rate, and the civilian unemployment rate. The relative returns from the alternative choices may change over time; we assume that it is these relative rewards at each point in time that influence the reservist's decision about whether to continue in military service.

A model in which the covariates change over time implies, ir principle, a three-dimensional data set with measurements on the time-varying covariates for each individual at each point in time.[1] The amount of data to be processed, and hence the cost of estimating the model parameters, increases with the number of individuals in the sample and with the number of points at which measurements on the time-varying covariates are taken. Because of the expense of fitting the proportional hazards model with time-varying covariates, we have estimated the model using data on a 10 percent random subsample[2] of our analysis sample: 1037 individuals from the Army Reserve and 1261 individuals from the National Guard. We have also limited our measurement of the time-varying covariates to each anniversary date.

We checked the estimates that we obtained from the subsample by fitting a model on the full analysis sample using measures of the pay and unemployment variables taken only at the time of accession. This procedure measures with error the returns from the alternative options that the individual faces at each decision point. If we assume that the error in measurement is random, our estimate of the effect of the pay and unemployment measures will understate the true effect in this case. On the whole, however, the estimates from both the full-analysis sample and the subsample are quite similar, although the estimates in

[1]With time-varying covariates, the attrition rate function is given by $h(t;x_t) = h_0(t)\exp(bx_t)$, where x_t denotes the characteristics of the individual at time t.

[2]This is a straight 10 percent random subsample, not a 10 percent subsample of each stratified cell.

the full sample are more precise in the sense of having smaller standard errors because of the larger sample size. We present both the full-sample and subsample estimates in the tables that follow. However, our discussion of the results centers on the estimates from the full sample, noting instances in which the model with the time-varying economic covariates produces different results.

Military pay at each anniversary is calculated based on reserve pay schedules and the personnel system data about pay grade and years of experience at each anniversary. The civilian wage rate and unemployment rate are those for the individual's home state during the quarter in which the anniversary occurs. We include a dummy variable to indicate whether the individual is eligible to receive a completion payment associated with an affiliation bonus; this variable also is time dependent since the payment will be realized on the fifth anniversary and subsequently the reservist will no longer be eligible to receive a completion bonus payment.

An indicator that the individual anticipates being eligible to obtain a reenlistment bonus at the next anniversary is set to one if he or she is in a unit or skill class that was eligible at the most recent anniversary, or at accession in the model estimated on the full sample. Our data on the units and skill classes that were eligible for bonuses from year to year were used to create the bonus variable. Finally, in our analysis with time-varying economic factors, we include a variable to indicate decision points at which an individual will be eligible to receive a completion payment from the reenlistment bonus if he or she continues to serve to the next anniversary. This last indicator is not included in the estimation on the full sample because at accession it takes the value of zero for everyone; this variable takes the value of one only after a reenlistment of three to six years by a bonus-eligible individual. An important shortcoming of the reenlistment bonus variable as it enters the time-varying model is the fact that we determine bonus eligibility using occupation at accession. However, there is substantial evidence to show that reservists change occupations frequently (Grissmer, Buddin, and Kirby, forthcoming). Bonus eligibility then can change from year to year as the recruit's occupation changes as well as changes in the skill classes designated to be eligible. Unfortunately, we do not have data on these occupational changes. Our bonus results are, therefore, biased to the extent that frequent changes in occupations mean frequent changes in bonus eligibility.

In fitting the proportional hazards model, we assume that the effect of a change in any covariate is a shift in the attrition rate that is constant over time. We investigate the validity of this assumption in two ways. First, we include an interaction term between time and specified

covariates in the model. The attrition rate function is then $h(t;x) = h_0(t)\exp(b_1x + b_2xt)$ and a unit increase in x shifts the attrition at time t by $\exp(b_1 + b_2t)$. If the proportional hazards assumption holds, then b_2 should equal zero (Cox and Oakes, 1984). We tested for an interaction between time and two of the key variables of interest—namely military pay and reserve bonus eligibility. The tests were made on the 10 percent subsample. The coefficient of pay interacted with time had a t-statistic of -1.3 in the model for the National Guard and -0.4 in the Army Reserve model. The t-statistics for the coefficient of time interacted with reserve bonus eligibility were -1.4 and -0.5. These results suggest that the proportional hazards model is not inappropriate, at least with respect to the compensation measures.

As a second check on the validity of the the assumption, we fit the proportional hazards model for separate subgroups of recruits and compared the plots of $\ln(-\ln(S(x)))$ for the separate subgroups. $S(x)$ is the survival function for the subgroup evaluated at covariate values x and is $S(t;x) = S_0\exp(\exp(bx))$. The baseline or reference survival function estimate is analogous to the Kaplan-Meier nonparametric estimate described in the previous section. If the proportionality assumption holds, the plots will exhibit constant differences across the separate subgroup (Kalbfleisch and Prentice, 1980). We compared plots of separate estimates of the model for subgroups defined by tertiles of the pay distribution and defined by eligibility for reserve bonuses. These comparisons used the entire analysis sample and we evaluated the function at an x vector given by the omitted group for classification variables and at the mean of continuous variables. The graphical technique also supported the proportionality assumption.

RESULTS

The estimation results for the Army Guard are given in Table 5.1; Table 5.2 contains the estimates for the Army Reserve. In addition to the coefficient estimates and their t-values, we present the multiplicative factor defined as $\exp(b)$, where b is the estimated coefficient. For the measures of reserve pay, civilian pay, and unemployment rate, the multiplicative factor gives the proportional shift in the attrition rate associated with a one dollar increase in pay or with a one percentage point increase in the unemployment rate. For the other characteristics, the multiplicative factor shows the shift in the attrition rate for an individual with the particular characteristic (e.g., with less than four years of prior military service at accession) relative to that for an

Table 5.1

PARAMETER ESTIMATES FOR COX REGRESSION ON TIME TO ATTRITION FROM THE NATIONAL GUARD, FY80–FY82 PRIOR SERVICE COHORTS

	Full-Analysis Sample, Baseline Characteristics				10 Percent Subsample, Time-Varying Economic Factors			
Variable	Beta Coefficient	Multiplicative Factor exp(Beta)	*t*-statistic	Chi-square	Beta Coefficient	Multiplicative Factor exp(Beta)	*t*-statistic	Chi-square
Reserve pay rate	−0.023	0.976	−4.346		−0.023	0.977	−1.9413	
Civilian wage rate	0.024	1.024	1.757		0.043	1.044	1.0277	
Unemployment rate	−0.014	0.985	−2.571		−0.021	0.978	−1.3205	
Affiliation bonus eligible	−0.072	0.930	−1.168		−0.245	0.782	−1.0852	
Reenlistment bonus eligible	0.041	1.042	1.496		0.125	1.134	1.4978	
Received reenlist bonus	—	—	—		0.542	1.719	1.3854	
Prior active service	0.096	1.101	3.635		0.122	1.130	1.4744	
Age at accession	—	—	—	65.32*	—	—	—	10.89*
26–30	−0.069	0.933	−2.057		−0.059	0.942	−0.5801	
31–35	−0.197	0.821	−5.268		−0.175	0.839	−1.5553	
36 or older	−0.318	0.727	−7.327		−0.416	0.659	−3.0599	
Years of service	—	—	—	3.48	—	—	—	0.88
Under 4	−0.038	0.961	−1.048		0.094	1.099	0.8555	
7–9	−0.017	0.982	−0.522		0.024	1.025	0.2322	
10–12	−0.076	0.926	−1.385		−0.010	0.989	−0.0653	
13 or more	−0.063	0.938	−1.105		0.028	1.029	0.1700	
AFQT category	—	—	—	0.98	—	—	—	3.07
Category I	0.010	1.010	0.201		0.229	1.258	−1.4634	
Category II	−0.000	0.999	−0.017		−0.054	0.946	−0.6540	
Category IV	−0.056	0.945	−0.949		0.002	1.003	0.0168	

Table 5.1—continued

Variable	Full-Analysis Sample, Baseline Characteristics				10 Percent Subsample, Time-Varying Economic Factors			
	Beta Coefficient	Multiplicative Factor exp(Beta)	*t*-statistic	Chi-square	Beta Coefficient	Multiplicative Factor exp(Beta)	*t*-statistic	Chi-square
Education	—	—	—	27.90*	—	—	—	3.30
Less than high school	0.166	1.181	4.869		0.036	1.036	0.3224	
Some college	−0.045	0.955	−1.176		−0.137	0.871	−1.1050	
College degree	−0.073	0.929	−1.349		−0.230	0.794	−1.3034	
Reserve occupation	—	—	—	8.25	—	—	—	6.01
Electronic equipment repair	0.105	1.111	1.527		−0.125	0.881	−0.6270	
Communications/intelligence	−0.025	0.974	−0.552		−0.147	0.862	−0.9428	
Health care specialist	−0.016	0.983	−0.279		−0.389	0.677	−1.9165	
Other technical specialist	−0.000	0.999	−0.009		−0.121	0.885	−0.4977	
Support/administration	0.000	1.000	0.023		−0.123	0.883	−0.9972	
Electrical/mechnical repair	−0.041	0.959	−1.183		−0.152	0.858	−1.4010	
Craftsman	−0.105	0.899	−1.598		−0.023	0.976	−0.1211	
Service/supply handler	0.003	1.003	0.080		−0.065	0.936	−0.5689	
Non-occupation	−0.095	0.908	−0.921		−0.424	0.653	−1.0098	
Married	−0.075	0.927	−2.822		−0.073	0.928	−0.8787	
Female	0.072	1.074	1.218		−0.029	0.970	−0.1775	
Black	−0.063	0.938	−1.891		−0.005	0.994	−0.0572	
Number of cases in sample		12,305				1,261		

NOTE: (1) The omitted categories are: age less than 25 years, 4–6 years of prior service, Category III, high school graduate, occupation infantry. Reserve pay is measured in pay per drill, civilian wage in dollars per hour, unemployment rate as a percent. (2) * Significant Chi-square at $p = 0.05$.

Table 5.2

PARAMETER ESTIMATES FOR COX REGRESSION ON TIME TO ATTRITION FROM THE ARMY RESERVE, FY80–FY82 PRIOR SERVICE COHORTS

	Full-Analysis Sample, Baseline Characteristics				10 Percent Subsample, Time-Varying Economic Factors			
Variable	Beta Coefficient	Multiplicative Factor exp(Beta)	*t*-statistic	Chi-square	Beta Coefficient	Multiplicative Factor exp(Beta)	*t*-statistic	Chi-square
Reserve pay rate	−0.050	0.951	−8.947		−0.032	0.968	−2.502	
Civilian wage rate	0.048	1.050	3.184		0.063	1.065	1.417	
Unemployment rate	−0.019	0.980	−3.156		0.013	1.013	0.736	
Affiliation bonus eligible	−0.038	0.961	−1.192		−0.024	0.975	−0.224	
Reenlistment bonus eligible	−0.109	0.896	−3.254		0.029	1.030	0.252	
Received reenlist bonus	—	—	—		−0.749	0.473	−2.846	
Age at accession	—	—	—	108.42*	—	—	—	22.60*
26–30	−0.179	0.835	−4.869		−0.105	0.899	−0.856	
31–35	−0.412	0.661	−8.447		−0.288	0.749	−1.862	
36 or older	−0.501	0.605	−8.506		−0.404	0.667	−2.182	
Years of service	—	—	—	11.09*	—	—	—	7.08
Under 4	−0.091	0.912	−2.947		−0.044	0.956	−0.457	
7–9	−0.016	0.983	−0.347		−0.068	0.933	−0.435	
10–12	−0.085	0.918	−1.232		−0.303	0.738	−1.414	
13 or more	−0.081	0.921	−1.242		0.111	1.118	0.607	
AFQT category	—	—	—	6.25	—	—	—	5.29
Category I	−0.122	0.884	−2.315		−0.439	0.644	−2.490	
Category II	−0.044	0.956	−1.374		−0.134	0.873	−1.263	
Category IV	−0.007	0.992	−0.168		−0.140	0.869	−0.912	

Table 5.2—continued

Variable	Full-Analysis Sample, Baseline Characteristics				10 Percent Subsample, Time-Varying Economic Factors			
	Beta Coefficient	Multiplicative Factor exp(Beta)	*t*-statistic	Chi-square	Beta Coefficient	Multiplicative Factor exp(Beta)	*t*-statistic	Chi-square
Education	—	—	—	38.88*	—	—	—	12.40*
Less than high school	0.222	1.249	6.065		0.159	1.173	1.384	
Some college	−0.064	0.937	−1.259		−0.389	0.677	−2.152	
College degree	−0.059	0.942	−0.933		−0.070	0.931	−0.331	
Reserve occupation	—	—	—	16.15	—	—	—	6.35
Electronic equipment repair	−0.036	0.964	−0.445		−0.544	0.580	−1.572	
Communications/intelligence	0.015	1.015	0.318		−0.158	0.853	−0.939	
Health care specialist	−0.056	0.944	−1.128		0.100	1.105	0.632	
Other technical specialist	−0.033	0.967	−0.388		0.005	1.005	0.017	
Support/administration	−0.138	0.870	−3.607		−0.217	0.804	−1.775	
Electrical/mechnical repair	−0.043	0.957	−1.060		−0.065	0.936	−0.503	
Craftsman	−0.079	0.923	−1.206		−0.065	0.936	−0.299	
Service/supply handler	−0.032	0.968	−0.814		−0.160	0.851	−1.286	
Non-occupation	0.005	1.005	0.054		−0.763	0.466	−1.631	
Married	−0.107	0.897	−3.718		−0.212	0.808	−2.207	
Female	0.211	1.234	4.655		0.181	1.199	1.196	
Black	−0.050	0.950	−1.712		−0.118	0.888	−1.272	
Number of cases in sample		10,197				1,037		

NOTE: (1) The omitted categories are: age less than 25 years, 4–6 years of prior service, Category III, high school graduate, occupation infantry. Reserve pay is measured in pay per drill, civilian wage in dollars per hour, unemployment rate as a percent. (2) * Significant Chi-square at p = 0.05.

otherwise similar individual with the reference or omitted value for that characteristic (e.g., four to six years of prior service at accession).

Effects of Military Pay

Policymakers can affect reserve manpower levels by changing military compensation, either by adjusting the basic pay rate or by offering bonuses. Increases in the reserve pay rate significantly reduce the rate of attrition at any point in time. The multiplicative factor for reserve pay in the National Guard equation shows that a one dollar increase in pay reduces attrition by about 2.4 percent ((1 – 0.976)*100).[3] Using the average drill pay rate of $20 (in 1979 dollars) in our sample, a 10 percent increase in pay (i.e., an increase of $2) will reduce the attrition rate from the National Guard by 4.5 percent (1 – exp(–0.023*2) = 0.045, where –0.023 is the beta coefficient for the reserve pay rate from the estimates based on the full-analysis sample). For the Army Reserve, a 10 percent increase in pay leads to a 9.5 percent fall in the attrition rate. For example, the attrition rate function shown in Sec. III indicated that about 6 percent of prior service accessions to the Army National Guard who are in service at the first anniversary will leave on that anniversary; with a 10 percent increase in pay, this attrition rate could be reduced to 5.7 percent. For the Army Reserve, the 8.5 percent attrition rate on the first anniversary could be reduced to 7.7 percent with a 10 percent pay increase.[4]

Although we believe these estimates can inform policymakers, there are some limits in generalizing our estimates of the effects of changes in military pay to the changes that would result from a current policy change. Because our study is observational and not an experimental test of pay variation, the magnitude of the estimated response to pay may be biased by unmeasured factors that are correlated with both military pay and attrition. Second, there may be a selectivity problem of prior service reservists who chose to enlist during the period of our study. If these enlistees are not representative of other prior service accessions in the current and future periods, then the parameter estimates generated by our model may not accurately predict attrition for future accessions. This is an inherent problem in most studies that

[3]The 0.976 in the formula is the multiplicative factor for the reserve pay rate from the full-analysis sample results.

[4]These numbers suggest that a 10 percent increase in pay could increase the retention rate at the first anniversary by 0.32 percent in the National Guard and by 0.87 percent in the Army Reserve. These elasticities give the effect of a pay increase on retention at the date of the first anniversary, not the cumulative effect of a pay increase on increased retention during the first year.

limit analysis to particular cohorts; only analyses of subsequent cohorts can help validate our results.

Effects of Bonuses

Our results concerning the effects of bonuses on attrition are mixed. The affiliation bonus for prior active duty personnel is associated with lower attrition, as we hypothesized, but the effect is not statistically significant.[5] We find a statistically significant decrease in attrition among Army reservists eligible for a bonus if they reenlist for the requisite term at the next anniversary in the estimates from the full sample of Army reservists. Eligibility for a reenlistment bonus, however, is not significant in the other models that we estimated, and in fact has an unexpected positive sign in these models. We estimate that Army reservists who subsequently receive a reenlistment bonus are significantly more likely than otherwise similar reservists to continue service to receive the completion payments. However, the indicator for receiving a reenlistment bonus is associated with increased attrition, although not statistically significant, in the equation estimated for the National Guard.

As with the response to military pay rates, there are difficulties in estimating the effects of bonuses from an observational study. Reservists who are eligible for bonuses or who are receiving bonuses may differ from other reservists in ways we have not measured and for which we, therefore, cannot control. Reenlistment bonuses are specifically targeted to reservists in units or with skills where shortages occur. That is, bonuses are offered to reservists that the services have experienced difficulty attracting or retaining in the past, perhaps because they have more attractive civilian alternatives than individuals who are not in the groups designated as eligible for bonuses. Eligibility for bonuses, therefore, may be correlated with unmeasured attributes of the alternatives available to the individual that would introduce a positive bias in the estimate of the pure effect of being eligible for a reenlistment bonus on attrition. On the other hand, there is a self-selection bias in the estimate of the effect of the affiliation bonus and of the effect of receiving a reenlistment bonus. Individuals who accept reenlistment bonuses commit to serve for at least three years; individuals who are eligible for a completion payment as part of the affiliation

[5]Recall that the 30 percent of Army Reserve personnel who were missing data on whether their prior service was in the active or reserve force were assumed to be prior active duty personnel. A small proportion of these met the criteria for affiliation bonus eligibility. If they were incorrectly coded, then there is a small attenuation bias in our estimate of the affiliation bonus in the Army Reserve equation.

bonus commit to serve for at least 18 months. It would not be surprising to find that reservists who are willing to commit to a term of service longer than one year would be more likely to remain in service than individuals who choose shorter commitments. That is, the indicator for receiving an affiliation bonus or a reenlistment bonus may be correlated with an unmeasured propensity for reserve service that would tend to introduce a negative bias in the estimate of the pure effect of a change in military compensation on attrition.

Although the bonus program is not administered as an experimental design, attrition rates among a group of like reservists before and after a bonus is offered to the group provide a quasi-experimental comparison to estimate bonus effects. In Table 5.3 we present such a comparison. To estimate the reenlistment bonus effect, we select units or skill groups that first became eligible for a bonus in FY82 and compare attrition during the first 12 months by reservists who joined those units or skills in FY80, before eligibility, with those who joined the unit or skill in FY82, after eligibility.[6] For the comparison, we select only reservists who satisfy the other reenlistment bonus eligibility criterion—that they have fewer than ten years of previous military experience. This contrast is labeled "test group" in Table 5.3. Because such before and after comparisons may be confounded with other changes occurring over time, we also present a "control group" contrast to show the time trend. The control comparison gives attrition during the first 12 months by individuals in the FY80 and FY82 cohorts who joined units or skill classes that were not eligible for reenlistment bonuses during FY80 through FY83.[7] Again, we include only reservists who satisfy the other reenlistment bonus criterion.

To estimate the affiliation bonus effect, we compare attrition among prior active duty personnel who enter reserve service in FY80 with those who enter in later years; we restrict the comparison to those with five years of service as it is this group that may receive completion payments in connection with an affiliation bonus. We present this last comparison only for reservists entering the National Guard because, as we noted in Sec. III, we have a great deal of missing data about whether individuals entering the Army Reserve had prior active duty or prior reserve service.

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[6]We do not include the FY81 cohort in the "before bonus" group for units and skills that became eligible in FY82 because the announcement of eligibility might affect the decisions of some members of the FY81 cohort. Similarly, we do not include skills and units that became eligible in FY81 in the test group because the announcement might affect the decisions of some members of the FY80 (before) cohort.

[7]We require that the unit or skill be ineligible through FY83 because we want the decisions of the FY82 cohorts during the first 12 months to be unaffected by bonus eligibility.

Table 5.3

ATTRITION DURING THE FIRST YEAR AMONG ELIGIBLE INDIVIDUALS BEFORE AND AFTER BONUSES OFFERED
(Percent)

Type of Bonus and Contrast Group	National Guard	Army Reserve
Reenlistment bonus		
Test group		
Before bonus (FY80)	25	34
After bonus (FY82)	27	31
(Number of cases)	(728)	(423)
Control group		
FY80 cohort	22	31
FY82 cohort	23	28
(Number of cases)	(1952)	(1489)
Affiliation bonus		
Test group		
Before bonus (FY80)	30	—
After bonus (FY81, FY82)	24	—
(Number of cases)	(2076)	—

The findings in Table 5.3 suggest that eligibility for a reenlistment bonus has little effect on attrition during the first year. There is little change in attrition rates in the National Guard before and after the bonus. Although attrition rates for the Army Reserve fell in units and skill classes subsequent to offering them a bonus, this drop appears to mirror trends that occurred in other units and skills in the Army Reserve. The completion payment in the affiliation bonus, on the other hand, does appear to reduce attrition. We do not have a control comparison because the before and after contrast includes all individuals entering the reserves from active service who have a remaining military obligation. However, we do not see declining attrition rates in the National Guard over the period that would be confounded with the affiliation bonus effect.

Effects of Civilian Economic Conditions

The civilian pay and unemployment measures are significant, and of the hypothesized sign.[8] Again using the average values for the variables in the sample, a 10 percent increase in civilian pay (an increase of

[8]Except we obtain a positive although insignificant coefficient for unemployment for the Army Reserve model with time-varying characteristics.

0.61) leads to an estimated 1.5 percent increase in attrition in the Army Guard and to an increase of 3.0 percent in the Army Reserve.[9] A 10 percent increase in the unemployment rate (from 8.96 percent to 9.86 percent) leads to a 1.3 percent decrease from the National Guard, and to a 1.7 percent decrease in attrition from the Army Reserve.

The civilian wage rate and unemployment rate that we use measure with error the civilian opportunities facing any particular individual because the variables do not take into account the individual's skills and training. It would be preferable to use wage and unemployment measures that adjust for education or occupation as well as home residence, but such data series are not available. The measurement error will bias the coefficient estimates on the civilian pay and unemployment variables. Unfortunately, the usual econometric errors-in-variables result that the coefficient will be attenuated may not hold here. This is because the errors in measuring the civilian opportunities facing the individual cannot be assumed to be random, but are likely to be correlated with other covariates in the model such as education. As a result, the direction of bias in the coefficients on these variables is uncertain.[10]

The individual's military-related skills may correlate with the individual's specific opportunities in the civilian market which we cannot capture with our aggregate unemployment and wage measure. Therefore, reserve occupation is included as another indicator of the relative returns from civilian service and reserve service. On the other hand, there are no civilian counterparts for some military occupations, and reservists in these occupations may realize nonpecuniary gains from the opportunity to maintain these skills. Occupation, however, is not significant in either component. The chi-square statistic given for occupation (and the other demographic variables) tests the joint significance of all the coefficients associated with that particular demographic characteristic; in neither component is the chi-square for occupation significant.[11]

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[9]These estimates are based on the full sample using the baseline or accession values.

[10]For a discussion of the effects of measurement error on coefficients in multivariate regression under a variety of assumptions regarding the nature of the measurement error, see Marquis et al., 1981.

[11]The chi-square statistics represent the effect of deleting the explanatory variables from the full model. Those presented for the subsample come from fitting the proportional hazards model using the accession values of the pay and unemployment variables rather than allowing these characteristics to vary. This was done because of the high cost of estimating the model with time-varying covariates.

Effects of Individual Characteristics

In Sec. II we hypothesized that the current, perceived value of military retirement benefits increases with age and years of prior military experience and therefore that attrition would decrease with these characteristics. In both components, there is a significant inverse relationship between age and attrition. As with the descriptive analysis, the differences between age groups are quite striking even when controlling for other variables. The hazard of attrition from the National Guard is about 30 percent lower for an individual age 36 or older than for an individual age 25 or younger; the comparable figure for the Army Reserve is about 40 percent.

Years of previous military experience, however, does not have the hypothesized effect after we control for age. In the National Guard, prior military experience does not show a significant effect on attrition. Prior military experience, of course, indirectly affects attrition because the rate of military pay is dependent on years of experience. In the Army Reserve, the set of indicators for prior years of service is significant in the full sample; however, the effects are not monotonic and do not follow the hypothesized pattern.

Differences in education have large and significant effects on attrition, even after controlling for other variables. The hazard of attrition from the National Guard for those without a high school degree is 18 percent higher than for those completing high school; the difference is 25 percent in the Army Reserve. Overall, aptitude scores are not significantly related to attrition, once education and other factors are held fixed; however, Army reservists with the highest aptitude scores (Category I) are less likely to leave than other reservists. In the Army Reserve subsample, the multiplicative factors show some other large, although insignificant, differences among individuals with different aptitude scores, with the unexpected finding that Category IV enlistees are less likely to leave than Category III. However, this last result is not replicated in the whole sample.

The hazard of attrition from the National Guard is 10 percent higher among reservists whose prior military experience was in active duty than among those who served in the reserve. (We have not included this variable in the Army Reserve equation because this information was missing for over 30 percent of the Reserve records.) We had hypothesized earlier that this may be due to differences in information; individuals with previous reserve experience return with knowledge of what reserve service entails, whereas those whose previous military experience was in active service may enlist in the reserve with incorrect perceptions of what reserve service involves.

VI. CONCLUDING REMARKS

Despite the important role they play in manning the Selected Reserve, there has been scant research about the accession and attrition decisions of prior service individuals. Here we have presented new information about attrition among prior service reservists in the Army Reserve and Army National Guard and an analysis of how attrition decisions differ between reservists of differing characteristics and in different economic environments. The findings of this study, along with forthcoming results from our analysis of reserve accession decisions by individuals with military experience, can contribute to manpower planning in several ways.

First, the information about accession and attrition rates is necessary to project future manpower levels and to assess whether target levels will be met. Information about the composition of prior service cohorts is as important as the total number in reserve service, particularly years of previous experience when individuals join and differences in separation behavior among individuals as a function of their military experience, since this affects the amount that will be paid out in compensation for the force. Other work is being carried out at RAND to develop simulation methodology for policymakers to use to project future manpower levels under various scenarios about the characteristics of the civilian economy. Information from our analysis concerning attrition among different subgroups of reservists and its dependence on civilian economic conditions will be a crucial input to that type of simulation model.

In addition to projecting manpower levels, our analysis provides important insights about how policymakers can influence the size of the reserve forces. Our results about how individuals respond to economic incentives are especially timely given the Congressional directive to the Sixth Quadrennial Review of Military Compensation (QRMC) to study the reserve compensation system. To support the review, RAND has studied reserve personnel problems that may be remedied, at least in part, by changes in compensation and has recommended several priority areas for compensation reforms (see Grissmer, Buddin, and Kirby, forthcoming). One recommendation is that a primary goal of compensation reforms be to obtain longer consecutive service from both prior service and nonprior service recruits. Our multivariate analysis shows that the rate of military pay can significantly affect the length of service of prior service personnel; a 10 percent

increase in reserve pay is estimated to decrease attrition rates by about 5 to 9 percent. For the three cohorts of Army Reservists, the 10 percent increase in pay could have induced about 700 individuals who left on the first anniversary to extend their service beyond this; the comparable number for the National Guard is 300 individuals.[1]

Special bonuses as presently constituted may not offer as effective a compensation reform as changes in current pay. The preponderance of our evidence suggests that reenlistment bonuses do not affect attrition among prior service individuals; eligibility for a completion payment, however, is associated with lower attrition among those entering the reserves from active services. Although our findings concerning bonus effects may be confounded with other factors for which we are unable to control adequately, the results are consistent with an experimental test of special bonuses. The experiment found only very small effects of bonuses on reenlistment rates; however, bonuses do appear to influence the behavior of those who reenlist by encouraging them to sign up for a longer term of service and to serve longer after reenlistment (Grissmer and Hiller, 1983).

Changes in the retirement program offer a third way that the military can alter financial incentives to encourage longer service. We do not have direct measures of how the retirement package affects attrition and retention decisions, although proxy measures that are related to an individual's anticipated benefits from the retirement system such as age do hint at the potential of changes in these benefits to alter attrition. Current work at RAND for the QRMC includes a more direct assessment of the effect of changes in retirement benefits. That work, along with our estimates of the elasticity of attrition with respect to current pay, will allow QRMC to predict the cost-effectiveness of changes in various elements of the compensation package.

A second goal for compensation reforms that RAND has recommended is to reduce geographical shortages of personnel. Lack of flexibility in reserve compensation levels to address differences in local labor markets is identified as a problem giving rise to such shortages. Indeed, our empirical work shows that changes in civilian opportunities in the local market do significantly influence attrition from the reserves. Our estimates of the elasticity of attrition to changes in local conditions and to military pay can assist in designing compensation initiatives to overcome the geographic differences in manning success.

[1]This is an estimate of the effect of a pay increase on retention at the date of the first anniversary among those who would survive to the first anniversary at the lower pay; it is not the cumulative increase in retention beyond one year for a pay increase instituted at accession.

Our results firmly support a model in which reservists weigh the economic rewards from military service and from civilian alternatives in making decisions about reserve service. Our estimates about how individuals respond to these economic incentives can aid policymakers in designing policies that will be effective in retaining personnel and meeting manpower needs.

Appendix

HAZARD RATE FUNCTIONS FOR VARIOUS DEMOGRAPHIC GROUPS

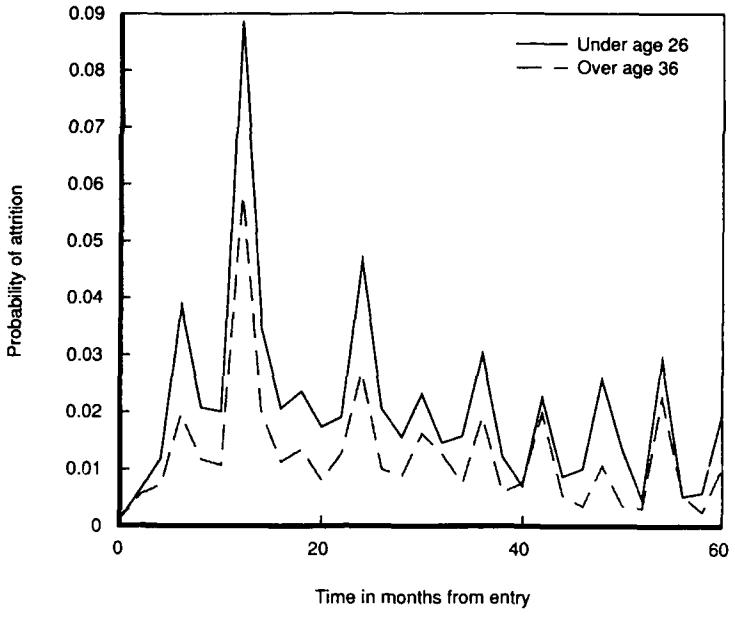

Fig. A.1—Probability of attrition, National Guard, by age

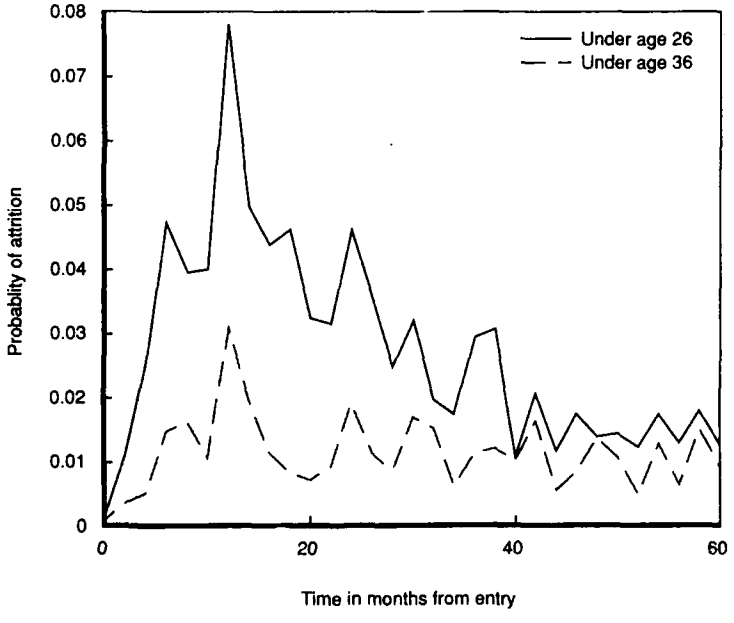

Fig. A.2—Probability of attrition, Army Reserve, by age

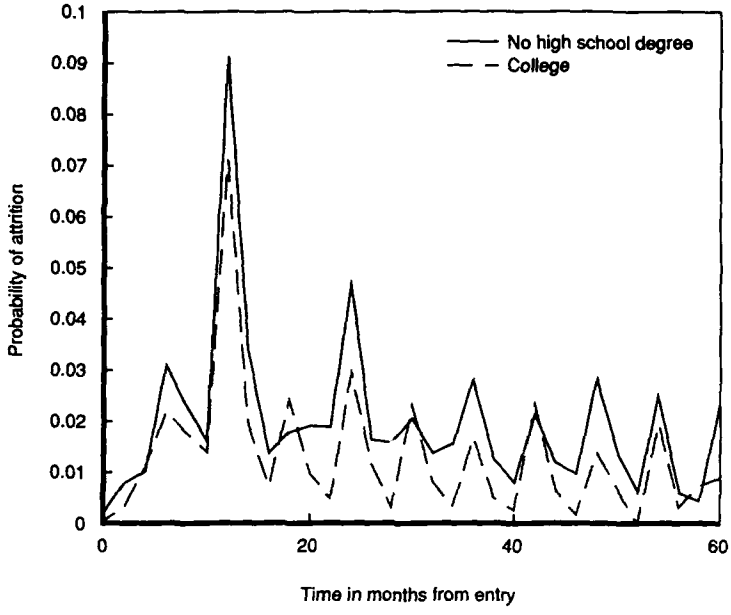

Fig. A.3—Probability of attrition, National Guard, by education

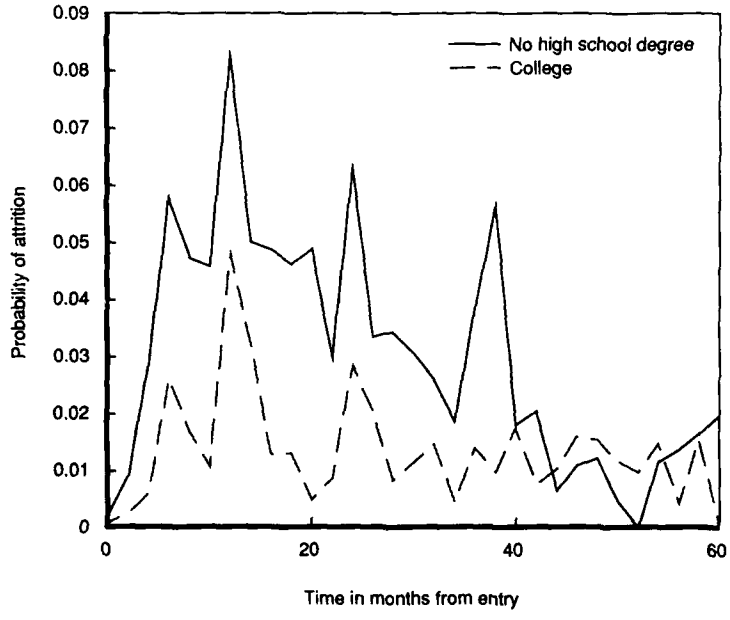

Fig. A.4—Probability of attrition, Army Reserve, by education

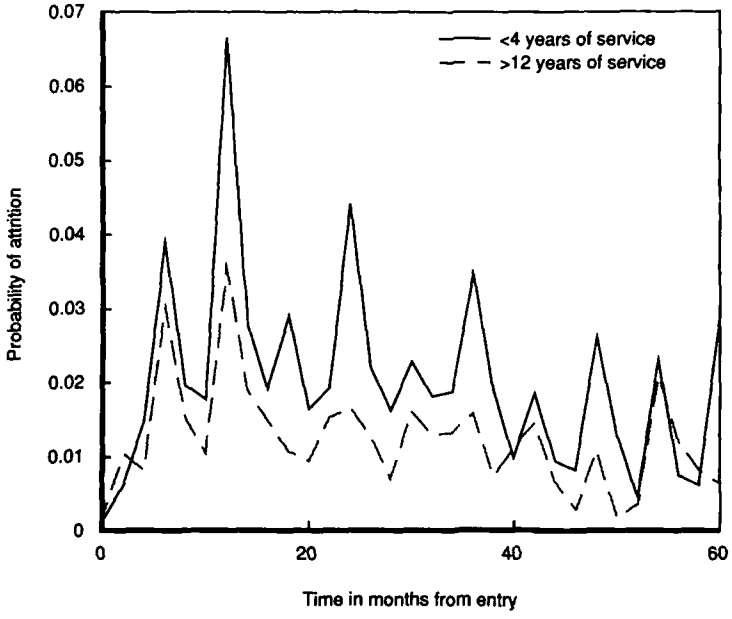

Fig. A.5—Probability of attrition, National Guard, by prior years of service

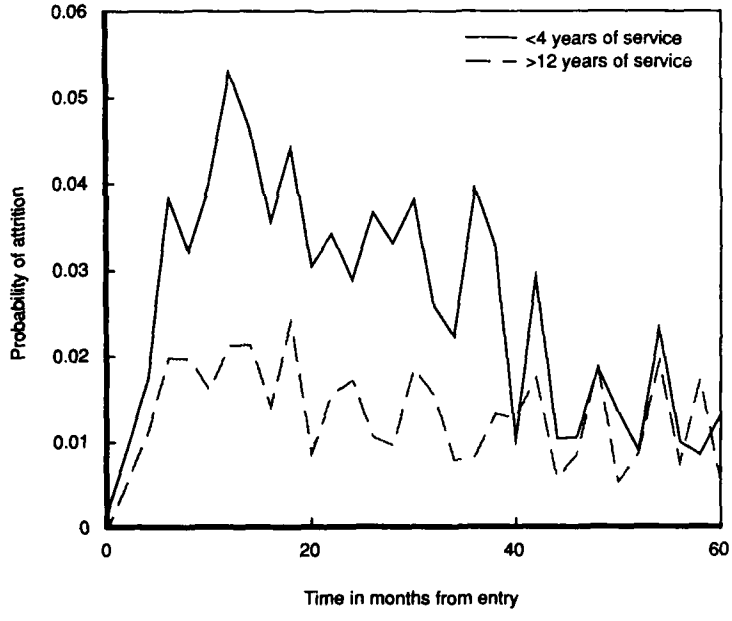

Fig. A.6—Probability of attrition, Army Reserve, by prior years of service

BIBLIOGRAPHY

Asch, Beth J., *A Technique for Estimating the Effect of Pay on Selected Reserve Supply,* Center for Naval Analyses, CRM 86-42, Alexandria, Virginia, March 1986.

Burright, Burke K., David W. Grissmer, and Zahava D. Doering, *A Model of Reenlistment Decisions of Army National Guardsmen,* The RAND Corporation, R-2866-MRAL, October 1982.

Cox, D. R., "Regression Models and Life Tables (with Discussion)," *Journal of the Royal Statistical Society B,* No. 34, 1972, pp. 187–220.

Cox, D. R., and D. Oakes, *Analysis of Survival Data,* Chapman and Hall, Ltd., London, 1984.

Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States, 1987,* Washington, D.C., p. 327.

Department of Defense, Office, Deputy Assistant Secretary of Defense (Reserve Affairs), *Official Guard and Reserve Manpower Strengths and Statistics,* various fiscal year summaries.

Department of Defense, *Recruiting and Retention Resources for the Reserve Components,* November 1985.

Department of Defense, *Manpower Requirements Report, FY 1988,* February 1987a.

Department of Defense, Office of the Secretary of Defense, *Military Compensation Background Papers,* Third Edition, June 1987b.

Grissmer, David W., Zahava D. Doering, and Jane Sachar, *The Design, Administration, and Evaluation of the 1978 Selected Reserve Reenlistment Bonus Test,* The RAND Corporation, R-2865-MRAL, July 1982.

Grissmer, David W., and John R. Hiller, *Follow-up of Participants in the 1978 Selected Reserve Reenlistment Bonus Test,* The RAND Corporation, N-1880-MRAL, February 1983.

Grissmer, David W., and Sheila Nataraj Kirby, *Attrition During Training in the Army Reserve and Army National Guard,* The RAND Corporation, N-2079-RA, August 1984.

Grissmer, David W., and Sheila Nataraj Kirby, *Attrition of Nonprior Service Reservists in the Army National Guard and Army Reserve,* The RAND Corporation, R-3267-RA, April 1985.

Grissmer, David W., and Sheila Nataraj Kirby with Priscilla M. Schlegel, *Changing Patterns of Nonprior Service Attrition in the Army National Guard and Army Reserve,* The RAND Corporation, R-3626-RA, July 1988.

Grissmer, David W., Richard Buddin, Sheila Nataraj Kirby, *Improving Reserve Compensation: A Review of Compensation-Related Personnel and Training Readiness Issues*, The RAND Corporation, forthcoming.

Kalbfleisch, J. D., and R. L. Prentice, *The Statistical Analysis of Failure Time Data*, John Wiley and Sons, New York, 1980.

Marquis, K. H., N. Duan, M. S. Marquis, J. M. Polich, J. E. Meshkoff, D. Schwarzbach, and C. M. Stasz, *Response Errors in Sensitive Topic Surveys: Estimates, Effects, and Correction Options*, The RAND Corporation, R-2710/2-HHS, April 1981.

Rostker, Bernard, *Air Reserve Personnel Study*, Vol. III, *Total Force Planning, Personnel Costs, and the Supply of New Reservists*, The RAND Corporation, R-1430-PR, October 1974.

Shiells, Martha E., *Affiliation of Navy Veterans with the Selected Reserve*, Center for Naval Analyses, CRM 86-249, Alexandria, Virginia, December 1986.