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# The Quality of Personnel in the Enlisted Ranks

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Beth J. Asch, John A. Romley, Mark E. Totten

Prepared for the Office of the Secretary of Defense  
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## Preface

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A key objective of the military's compensation and personnel systems is to attract, retain, promote, and motivate high-quality personnel in the armed services. This monograph summarizes research that uses data on enlisted personnel who entered the military between fiscal year 1978 (FY78) and FY92 and tracks their careers through FY96 to describe the quality of personnel who have entered, reenlisted, stayed through midcareer, and were promoted. Our analysis uses three quality measures, two based on entry characteristics (the Armed Forces Qualification Test [AFQT] score and education) and one that exploits first-term promotion to infer quality as revealed on the job. The analysis sought to identify whether higher-quality personnel stayed in service and were more likely to reach senior leadership positions in the 1980s and first half of the 1990s. The report should be of interest to those concerned about the quality of personnel in the armed forces.

The research presented in this report is part of two larger projects. The first seeks to analyze, develop, and make accessible new measures of personnel outcomes in the military; the second seeks to provide a theoretical and empirical framework to evaluate the structure and adequacy of the military's compensation system. Other documents produced as part of these projects include *A Theory of Military Compensation and Personnel Policy* (Asch and Warner, 1994b); *A Policy Analysis of Alternative Military Retirement Systems* (Asch and Warner, 1994a); *A Description of U.S. Enlisted Personnel Promotion Systems* (Williamson, 1999); *Patterns of Enlisted Compensation* (Kilburn, Louie, and Goldman, 2001); *An Examination of the Effects of Voluntary Separation Incentives* (Asch and Warner, 2001); and *Measuring the Quality of Enlisted Personnel in the U.S. Armed Forces* (Hosek and Mattock, 2002).

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## Summary

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As the armed services transform to develop capabilities to meet a spectrum of uncertain threats, a constant objective will be to ensure the military's compensation and personnel systems are structured to attract, retain, and promote high-quality personnel.<sup>1</sup> The research presented in this monograph provides evidence on the military's ability to meet these goals in the past, using two traditional and one nontraditional metric of personnel quality. Specifically, we use longitudinal data provided by the Defense Manpower Data Center (DMDC) through FY96 on enlistees who entered the military between FY78 and FY92 to address the following questions by service, occupational area, and cohort entry date:

- Are high-quality personnel more likely than low-quality personnel to enter the military and to complete their first terms? Are personnel who attrite of lower quality?
- Are high-quality personnel more likely to reenlist than are low-quality personnel?
- Are high-quality personnel more likely to stay beyond their first term, e.g., to their early and midcareer, than are low-quality personnel?
- Are high-quality personnel more likely than low-quality personnel to be promoted?

The traditional measures of personnel quality are the Armed Forces Qualification Test (AFQT) score and high school diploma status. The AFQT is a composite of four of the subtests of the ten-part Armed Services Vocational Battery (ASVAB) administered to all recruits prior to enlistment. It was designed as an enlistment test to predict success in training and on-the-job performance. The services use various composites of the ASVAB to predict job skill (occupational) training. In the 1980s and 1990s, the Department of Defense sponsored the Joint-Service Job Performance Measurement (JPM) Project to address whether AFQT scores actually predicted job performance. The JPM research study provided strong evidence of a positive relationship between AFQT scores and "hands-on" (or work sample) measures of performance across the four services (Wigdor and Green, 1991). More recent analysis of the Army's portion of the JPM Project, Project A, demonstrated a relationship between AFQT scores, effort, and leadership metrics (Oppler et al., 2001). As for high school diploma status, attainment of a diploma was found to be associated with a higher probability of completing the first term of enlistment.

As metrics of performance, AFQT scores and high school diploma status have the advantage of being available to the military before entry, and therefore, before expensive re-

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<sup>1</sup> Although these have always been objectives underlying the systems, the general principles of the compensation system were first articulated by the Seventh Quadrennial Review of Military Compensation in 1992 and summarized in the fifth edition of the *Military Compensation Background Papers* (Morris, 1996).

cruiting and training costs have been incurred. As such, they have proven to be an excellent method for identifying at entry individuals who are likely to complete their first term and perform successfully on tasks that are important for their military jobs. Yet, as noted by Mayberry and Carey (1997) in their analysis of the Marine Corps segment of the JPM study, the hands-on performance tests used in the JPM study do not capture all dimensions of performance under all circumstances. For example, they note that the tests “do not necessarily measure a Marine’s ability to operate in a hostile environment, or to work effectively with others” (Mayberry and Carey, p. 146). More broadly, taste, suitability, discipline, fitness, and career potential might be factors that affect performance independently of AFQT scores. Also, the focus of the JPM study was on the relationship between aptitude and performance, holding job experience constant. Performance may be revealed over time as the individual member experiences military service, that is, as his or her “goodness of fit” is learned by both the service and the individual. Individuals learn whether they enjoy the regimented lifestyle the military offers, whether they can manage successfully the inherent dangers and associated stresses, the frequent moves, the demanding work schedule, and the requirements for physical fitness. In turn, the services learn whether the individual is successful at adapting and performing in the military environment, is suitable in the current job, and has future career potential. Thus, as useful as AFQT scores and education are as metrics of entry quality and correlates of subsequent job performance, additional metrics would be useful that capture information about quality revealed on the job and over time. In this study, we use a nontraditional measure of personnel quality, the so-called “quality index.”

The quality index is a metric of personnel quality developed by Ward and Tan (1985) and extended recently by Hosek and Mattock (2002). This index is intended to reflect the overall quality of the job match between a member and the military as revealed over time, both by AFQT score and other factors. As we have suggested, determinants of this match may include innate ability but also job proficiency and knowledge, attitude, effort and initiative, ability to work successfully under duress or with others in a team environment, capabilities to learn and perform military-specific skills, and leadership and career potential in future positions. The index is formulated to be the sum of the member’s observed and unobserved quality characteristics. The observed characteristics may include the traditional measures of AFQT score and education. Observable characteristics embody the quality that can be expected at entry from such personnel. The unobserved factor reflects a persistently good or bad match relative to other personnel who appeared comparable upon enlistment. The importance of the unobserved factor to the quality index indicates the degree to which quality is revealed on the job.

The quality index is estimated using information on promotion speed for members in a given service, enlistment cohort, and occupation, where the size of the correlation in promotion speeds to E-4 and E-5 provides information about the relative importance of the unobserved quality factor. For example, holding AFQT scores constant, fast trackers will have a higher unobserved quality factor that causes them to be promoted more quickly to E-4 and E-5 relative to their peers in their occupation and enlistment cohort. To the extent that promotions are based on assessments of current performance and suitability in both current and future positions, the quality index is a more informative measure of quality than the traditional measures. Hosek and Mattock (2002) apply the Ward-Tan method using the DMDC longitudinal data used in our study, and estimate a quality index by service and three-digit Department of Defense (DoD) occupation code for enlisted personnel entering

service from FY78 to FY92. In this monograph, we regenerate the quality index for a set of illustrative three-digit DoD occupations, using the computer programs and results of the Hosek and Mattock study, and use it, together with the two traditional measures of personnel quality—AFQT score and high school diploma status—to examine whether high-quality personnel are enlisted, retained, and promoted to their early and midcareer, specifically to year of service (YOS) 4, YOS 8, and YOS 12. While our analysis of personnel outcomes in the first term is quite rich (e.g., distinguishing among entry cohorts, services and occupations), our analysis of retention and promotion through the midcareer is the main contribution of this monograph.

To answer questions about the quality of those who leave or attrite versus complete the first term of enlistment, we compare the mean quality of those who leave versus those who complete. To answer questions about the quality of reenlistees, we compare the mean quality of those who reenlist versus those who separate at the end of their first term. To answer questions about the quality of those retained through the early and midcareer years, we compare the average quality of those at the fourth, eighth, and twelfth YOS with the average quality of those who enter. These years roughly correspond to the end of the first, second, and third term of enlistment. If the average quality is higher at these points than at entry, we conclude that those who are retained are of better quality than those who separated. Finally, to answer questions about the quality of those in the upper ranks, we compare the average quality of those in the upper grades with the average quality of those in the lower grades, holding YOS constant. In the process of answering these questions, we also present trends over time in attrition, reenlistment, first-term retention, and midcareer retention.

## Results

Table S.1 summarizes the results. In terms of AFQT and education, the average quality of entering recruits rose dramatically in the early 1980s, as has been well documented in previous studies; the quality index cannot be estimated for those who do not enlist. Using AFQT score as the measure of personnel quality, we find that across entering cohorts and occupational groups, the average quality of those who attrite is generally not much different than those who complete their first term, that those who reenlist are slightly lower in average quality than those who separate at the end of the first enlistment term in the Army and Navy, and that those who stay until their early and midcareers are not much different in terms of average quality than those who leave, with the exception of a few occupational areas and cohorts in the Navy and Marine Corps. In general, the differences in average AFQT scores of those retained versus those who leave are generally quite small. We also find that those in the upper grades have significantly higher AFQT scores on average than those in the lower grades, holding YOS constant. Therefore, based on AFQT scores, we would conclude that the average quality of personnel that the services recruit is the quality they generally end up keeping through the midcareer.

**Table S.1**  
**Summary of Results for Cohorts Entering FY78 to FY91: Are Higher-Quality Enlisted Personnel Recruited and More Likely to Complete Their First Terms? Are Higher-Quality Personnel Retained? Are Higher-Quality Personnel Promoted?**

Question	Measure of Personnel Quality		
	AFQT	High School Diploma Status	Quality Index
Do higher-quality personnel enlist?	Yes, except for early cohorts	Yes, except for early cohorts	Not available
Do higher-quality personnel complete their first terms?	About the same	Yes, early cohorts	Yes
Are higher-quality personnel retained:			
At the end of their first term?	No, but only slightly	Yes, early cohorts	Yes
Through the early career (YOS 4)?	Slightly no	Yes, early cohorts	Yes
Through the midcareer (YOS 8)?	Slightly no	Yes, early cohorts	Yes
Through the midcareer (YOS 12)?	Slightly no	Yes, early cohorts	Yes
Have higher-quality personnel been promoted as of:			
YOS 4?	Yes	Yes, early cohorts	Yes
YOS 8?	Yes	About the same	Yes
YOS 12?	Yes	About the same	Yes

SOURCE: Authors' calculations using the Defense Manpower Data Center (DMDC) Defense Special Cohort Accession Continuer (DSCAC) file.

We find that using education, and specifically high school diploma attainment, as a measure of quality, is problematic in the later cohorts in our data (FY84 through FY92) because almost all enlisted personnel in recent years have been high school graduates. Therefore, for the later cohorts, we tend to detect little difference in the quality of those who stay, leave, or get promoted.<sup>2</sup> Using this measure, we conclude that the quality of those recruited is the quality that is retained and promoted.

However, the quality index results lead us to a different conclusion. Using the quality index as our measure of quality, we find that those who complete their first term, those who stay until the eighth or twelfth YOS (that is, to their midcareer) and those who are promoted to higher grades are of significantly higher quality. We find these results even among more recent cohorts. The conclusions we draw about the quality of personnel retained differ when we use the quality index because it is designed to include information about quality that cannot be predicted at entry but is instead revealed on the job.<sup>3</sup>

<sup>2</sup> However, when high school diploma attainment varies significantly, such as in the FY80 Army cohort, we see that the quality of those who completed their first terms, who stayed until their midcareers, or who were promoted (through YOS 8), was significantly higher than those who left or were not promoted.

<sup>3</sup> Research from Project A shows a relationship between AFQT scores and effort and leadership (Oppler et al., 2001). We argue that the quality index incorporates both the quality that can be expected due to AFQT score and new information as revealed through the promotion process. Thus the index adds information to AFQT score. Furthermore, the focus of our study is on whether high-quality personnel are retained. Based on AFQT score, it appears that those of higher quality are neither more nor less likely to leave the service. Based on the quality index, we find that higher-quality personnel are more likely to stay.

While the quality index has clear advantages as a more informative measure of personnel quality, we should note its limitations.<sup>4</sup> The quality index methodology rests on a key assumption, specifically that promotion speed to E-4 and E-5 reveals information about job-related performance during the first term. This assumption is generally reasonable to the extent that the military's promotion systems are merit based for members in a given occupation in a given service, enlistment cohort, and occupational area; our analysis is indeed conducted holding cohort, service, and occupation constant.

Though reasonable, the assumption that promotion is merit based within a cohort, service, and occupation does limit the quality index's value somewhat. With the traditional measures of quality, one could assess whether the military became more or less successful in retaining and promoting high-quality enlisted personnel within each cohort over the period FY78–FY92. Yet the quality index cannot be compared across cohorts, services, or occupations. Nevertheless, we can and do address the policy-relevant issue of whether the military was consistently successful in absolute (if not relative) terms across cohorts, service, and occupation, only within these categories.

In conclusion, the results of this study show the value of developing a measure of quality that includes information not only about entry characteristics but also about assessments of performance during and through the end of the first enlistment term. While the quality index uses information about promotion speed in the first term, other information could also be used. For example, the quality index method could be adapted to use information on promotion points awarded for supervisor ratings, skill test performance, and so on (Buddin et al., 1992), as of the end of the first term. Furthermore, the method could be expanded to incorporate information beyond the first term, such as promotions to E-5 that occur during the second term or even promotions to E-6. The development of such improved measures of quality should be a topic for future research.

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<sup>4</sup>The limitations are discussed further in both the Ward and Tan and the Hosek and Mattock studies.



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## Acronyms

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AFQT	Armed Forces Qualification Test
ASVAB	Armed Services Vocational Batteries
COLA	cost-of-living adjustment
CPI	Consumer Price Index
DMDC	Defense Manpower Data Center
DoD	Department of Defense
DSCAC	DMDC Special Cohort Accession and Continuer
ETS	expected term of service
IT	information technology
JPM	Job Performance Measurement
MEPCOM	Military Entrance Processing Command
MOS	military occupational specialty
NCO	noncommissioned officer
OSD	Office of the Secretary of Defense
QDR	Quadrennial Defense Review
YOS	year (or years) of service



## Introduction

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In 2001, the Department of Defense articulated a new defense strategy in its *Quadrennial Defense Review* (QDR). This strategy shifted the focus from meeting specific threats and planning for two major simultaneous wars, to one that requires developing capabilities to deter and defend against a spectrum of unknown and uncertain threats. The QDR identified several major goals of the strategy including protecting the U.S. homeland, protecting information networks from attack, and projecting and sustaining power in distant environments. To be successful, this strategy requires transformation of the armed services. As stated by U.S. Defense Secretary Donald Rumsfeld, transformation calls for a change in terms of “the way we think, the way we train, the way we exercise, and the way we fight.” It must “encourage a culture of creativity and intelligent risk taking” and “promote a more entrepreneurial approach to developing military capabilities” (DoD, 2002).

In terms of the implications of transformation for manpower requirements, transformation will require innovative and flexible ways of using military personnel, and personnel can expect to have different kinds of military careers. Past commissions and studies have defined what is meant by more flexible use of personnel. As outlined in Asch and Hosek (2004), the definitions include more variations in military career lengths, more flexibility in the length of time reserve personnel are called to service, fewer moves, longer time in an assignment, more variation in time in grade, and development of multiple career tracks. While some of these ideas are still being vetted, the services and DoD generally accept that transformation at a minimum will continue to mean attracting, retaining, and motivating talented personnel and promoting and sorting the best into senior leadership positions.

Given the far-reaching changes suggested by transformation, a key question is whether the military compensation and personnel systems can accommodate these changes or whether changes to these systems are necessary and important for achieving the goals of transformation. More specifically, whether the systems are adequate in terms of delivering high-quality personnel to the armed services and enabling them to retain those personnel is a key question. A full answer to this question requires an objective standard for judging adequacy and a benchmark for determining how much quality is enough to meet the services’ manpower requirements.

In recent years, the Office of the Secretary of Defense (OSD) has established a benchmark of recruit quality that calls for 60 percent of new recruits to score above the 50th percentile on the AFQT and 90 percent to have a high school diploma. OSD, in conjunction with the National Academy of Sciences, developed a model that links job performance, measured in terms of scores on hands-on job performance tests, to recruit quality and recruiting resources and training costs (Smith and Hogan, 1994; Green and Mavor, 1994; Wigdor and Green, 1991). These recruit-quality benchmark standards chosen by OSD cor-

respond to the level of performance provided by the 1990–1991 enlisted cohort, a group whose performance during Operations Desert Shield and Desert Storm was satisfactory (Sellman, 1997). However, beyond recruit quality, neither the services nor OSD has requirements or benchmarks for personnel quality for retention, nor any explicit indication of how requirements for personnel quality might change as external factors such as cost, including compensation, change. Furthermore, even within the first enlistment term, there is a recognition that personnel quality may evolve over time as individuals become aware of their suitability to the regimented military lifestyle or ability to manage in hostile or stressful situations. Additional metrics of personnel quality would be useful, as would benchmarks for assessing the adequacy of compensation. At present, the services do not have benchmarks beyond recruit quality.

The intention of this monograph is to take a first step toward assessing the adequacy of the compensation and personnel systems. It examines whether the services could attract, retain, and promote high-quality personnel during the period covered by the data we analyze, from 1978 to 1996, using the three measures of quality, two based solely on entry characteristics, AFQT score and education, and one that uses information from first-term promotions to E-4 and E-5. Specifically, we use data that track until FY96 the careers of military enlistees who entered between FY78 and FY92 and describe, by service, occupational area, and cohort entry date, the quality of personnel who enter, leave, reenlist, and are promoted.

## The Structure of Military Compensation

This first step toward assessing the adequacy of the compensation and personnel systems is useful only if changes to these systems can accommodate the changes demanded by transformation. Indeed, past commissions and study groups have questioned whether the current compensation system can do so, because the structure of the system has changed relatively little since the end of World War II.<sup>1</sup> While the structure of the military compensation system has been stable in important respects, there is some reason to believe that the military's compensation and personnel systems are flexible enough to meet changing needs in the context of an all-volunteer force.

The two largest components of military compensation in terms of cost are basic pay and the retirement system. Together, they accounted for about 62 percent of the DoD compensation budget in FY 2004. The military's basic pay table is the same for all services and occupational areas. In it, one's pay increases with YOS and with promotion to a higher grade. Table 1.1 shows how pay varies with grade, drawing from figures produced by the Congressional Budget Office (1995, Table 9) and updated here. For example, in 2004, pay ranged from 56 percent of an E-5's pay for an E-1 to 224 percent for an E-9. The Career Compensation Act of 1949 established the general structure of the pay table. Except for pay raises for junior enlisted personnel in 1971 in anticipation of the end of the draft in 1973, the structure of the pay table has remained relatively stable, especially for those in the more

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<sup>1</sup> Among the most recent commissions to do so was the 2000 Defense Science Board Task Force on Human Resource Strategy (U.S. DoD, 2000), which recommended that the military pay table be restructured to place greater emphasis on payment for skills and performance, and that the retirement system be reformed with a new system that would vest personnel earlier in a 401(k)-type option, with benefit portability.

**Table 1.1**  
**Basic Pay by Grade Relative to Pay of an E-5 or O-3 (in Percent), by Year**

Pay Grade	Median YOS	1949	1958	1971	1981	1995	July 2000	2005
E-1	1	49	40	63	59	59	59	56
E-2	1	51	41	70	67	67	66	63
E-3	2	59	47	73	69	69	68	66
E-4	4	77	76	85	82	82	84	77
E-5	8	100	100	100	100	100	100	100
E-6	13	127	126	125	125	125	124	126
E-7	17	155	150	147	148	148	147	151
E-8	20		171	169	170	170	171	174
E-9	25		210	208	209	217	218	224
O-1	2	63	51	55	55	55	55	54
O-2	3	77	66	69	69	69	72	70
O-3	7	100	100	100	100	100	100	100
O-4	14	125	125	121	121	121	127	128
O-5	20	154	164	152	152	152	154	151
O-6	24	188	207	184	183	183	186	182

SOURCES: Congressional Budget Office, 1995, p. 41. The authors computed the figures for 2005 and July 2000 based on sources provided by the Office of Compensation within the Office of the Under Secretary of Defense for Personnel and Readiness.

senior grades. For example, the pay of an E-1 relative to that of an E-5 fell from about 50 to 40 percent in the 1950s then rose. Since 1949, the pay of an E-7 relative to an E-5 has remained about the same, as has the pay of an O-6 relative to an O-3. After receiving a 4.8 percent across-the-board pay raise in January 2000 that was the same for all members, members in July 2000 received targeted pay raises that gave higher raises to those in specific pay grades and with specific YOS. As a result of the targeted raises, the pay table structure in 2004 is more similar to the 1940s design.

The basic structure of the military retirement system has also remained intact since 1948, despite changes to the system in 1981 and 1986;<sup>2</sup> under the military's retirement systems, individuals who complete 20 YOS can collect immediate benefits, regardless of age. The benefit one gets is determined by grade and YOS. The systems are the same for all active duty service members, regardless of occupation or service.

<sup>2</sup> The three systems are structured as follows. Pre-FY81 entrants receive retired pay according to the formula  $0.025 * \text{YOS} * \text{final basic pay}$ , such that 20-year retirees receive 50 percent of final basic pay and 30-year retirees receive 75 percent. Importantly, retired pay for this group is fully inflation protected. Retired pay for those who entered between FY81 and FY86 is calculated similarly except that pay is based on the average of the individual's three highest years of basic pay rather than on final basic pay. It is also fully indexed for inflation.

The Military Retirement Reform Act of 1986, also known as REDUX, implemented several important changes. First, the annuity formula was changed to  $[0.40 + 0.035 * (\text{YOS} - 20)] * \text{high} - 3 \text{ average basic pay}$  for the years between separation and age 62, at which time pay reverts to  $0.025 * \text{YOS} * \text{high} - 3 \text{ average basic pay}$ . Consequently, retired pay during the transition between military service and full retirement ranges between 40 percent of the highest three years' average basic pay at YOS 20 and 75 percent of the highest three years' basic pay at YOS 30. Second, rather than indexing retired pay for inflation, the annual cost-of-living adjustment (COLA) between separation and age 62 is one percent less than the percentage growth in the Consumer Price Index (CPI). At age 62, retired pay is then fully adjusted for the CPI growth since separation. But thereafter it again increases according to the CPI-minus-one-percent rule. The 1986 reforms thus changed the

Past research (Hosek and Peterson, 1985a, 1985b; Asch, Kilburn, and Klerman, 1999) has shown that personnel enlistment and reenlistment decisions depend not just on military compensation but on military compensation relative to the alternative compensation found in the civilian sector. In the early years of the All-Volunteer Force, military pay was allowed to decline relative to civilian pay, but large pay increases in the early 1980s restored parity. More recently, military pay increased by almost 30 percent on average in nominal dollars between 1999 and 2004, with higher targeted raises among enlisted personnel and junior and midcareer officers. Therefore, despite the apparent rigidity over time of the existing military compensation systems, they have accommodated large pay changes over the years.

Military compensation can also be varied through the use of special and incentive pays as well as bonuses such as enlistment and reenlistment bonuses. The services can target these pays across personnel and over time as a way of increasing compensation in response to more arduous or dangerous military duty, higher civilian pay, or changes in the civilian economy that causes insufficient supply in critical skill areas to meet staffing requirements. However, as shown in Asch, Hosek, and Martin (2002) bonuses and special and incentive pays are small, on average, as a component of overall cash compensation. The average values are low because there are over 40 different special and incentive pay categories, most personnel do not receive any given category, and many pays are not large. As a result, the military compensation system leads to highly similar pay levels at each YOS across occupational areas within each service and even across services. On the other hand, variation in cash compensation comes mainly from special and incentive pays as well as from bonuses.

Promotion speed is another important source of variation in military compensation over time and across personnel. The services operate their promotion systems differently (Williamson, 1999). The Navy tests and promotes personnel to E-4 and E-5 in six-month intervals, whereas the Army tests and promotes personnel to E-4 and E-5 continuously throughout the year. The services also use somewhat different criteria for promotions and place different weights on such factors as supervisor ratings, skills, fitness, and test scores.

## Past Studies

A number of other studies have examined whether high-quality personnel, measured in terms of AFQT score and education enter, stay, and are promoted in the military. Smith, Sylwester, and Villa (1991) used longitudinal data on Army personnel who entered between 1974 and 1984 and found that personnel with higher AFQT scores and more years of education were generally less likely to reenlist at the first reenlistment point. However, the estimated effect of AFQT on reenlistment was not large.

Buddin, Levy, Hanley, and Waldman (1992) recognized that individuals base their first-term retention decisions in part on whether they expect to get promoted. As a result, the estimated effect of AFQT score on retention, without controlling for promotion opportunities, reflects both the retention supply of higher-quality personnel and the effects of AFQT score on opportunities for promotion in the future. Because those with higher AFQT scores

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system by (1) reducing the amount received at YOS 20, (2) raising the growth in retired pay for each year served after YOS 20, and (3) reducing the real value of the stream of retired pay in an inflationary environment.

probably have better outside opportunities, the true effect of AFQT score on retention (i.e., the direct effect when promotion opportunities are held constant) is probably negative. Using data on Army and Air Force personnel who completed their first enlistment between FY83 and FY89, Buddin et al. (1992) estimate a joint model of promotion and first-term retention in which AFQT score appears as a covariate in each equation. The researchers control for the effect of promotion opportunities by including expected time to E-5 in the equation for first-term retention and find evidence of a larger direct effect of AFQT score than found by past studies (such as Smith, Sylwester, and Villa, 1991). For example, for Army personnel, they find that the direct effect of a 15-percentage-point increase in AFQT score is a 3.5-percentage-point decrease in retention, while the total effect is a 0.5-percentage-point decrease, because a higher AFQT score lowers the expected time to E-5. For Buddin et al. (1992), the effects of having a high school diploma were mixed. In some model specifications, diploma graduates were more likely to be retained, but in others, they were less likely to be retained. However, regardless of specification, the study found that the relationship between education and retention diminished when promotion was taken into account.

Warner and Solon (1991) estimate a joint model of Army attrition and retention that includes AFQT score and high school graduation status as covariates, using data from 1974 to 1983. Their model recognizes that those facing a reenlistment decision are a nonrandom group of members who did not attrite. Among their findings is that high school graduates are much more likely to survive their first terms, but less likely to reenlist. Those graduates with scores in the top half of the AFQT score distribution were found to be more likely to survive their first terms, though the estimated coefficients were relatively small, but were less likely to reenlist.<sup>3</sup>

Ward and Tan (1985) developed a new measure of military personnel quality and examined whether the average quality of those who reenlist at the end of their first term is higher. This measure, discussed in greater detail in Chapter Two, is intended to indicate the overall quality of the job match between a member and the military as revealed over time. This match depends not just on ability, but also on effort and taste for military service. The measure incorporates not only entry characteristics like AFQT or education but also an unobserved quality factor. Observed entry characteristics embody the job match that can be expected upon enlistment. The unobserved factor reflects a persistently good or bad match relative to other personnel who appeared comparable at entry. In the Ward-Tan model, the promotion process reveals information about quality through its assessment of actual performance. Those who are promoted faster to the grades of E-4 and E-5, holding AFQT constant, are considered to be individuals whose unpredictable (at entry) component of personnel quality is greater. Using this more informative measure of quality, Ward and Tan find that, among the nine occupations they examined in the 1978 entry cohort, the average quality of those who reenlisted was significantly higher than that of those who left at the end of the first term.

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<sup>3</sup> These studies provide evidence on education and completion of the first term. A large body of evidence exists on the relationship between high school graduation and completion of early first-term training. For example, Buddin (1988) documents trends in six-month attrition rates and recruit quality. More recent evidence on early completion of Marine Corps recruit training and recruit quality is provided by Hattiangadi, Lee, and Quester (2004). Armor and Sackett (2004) summarize evidence on 24-month attrition rates by education between 1988 and 1998. High school diploma graduates have a 23.4-percent attrition rate compared to a 43.7-percent rate among nondiploma graduates.

Hosek and Mattock (2002) apply the Ward-Tan quality model to more recent longitudinal data on enlisted personnel—those joining the military between fiscal years 1978 and 1992. They find that AFQT score is positively related to the Ward-Tan measure of quality, as expected. They also decompose the variance in the quality measure into the contribution of AFQT and the contribution due to the unobserved member-specific quality factors. On average, across three-digit DoD occupation codes, the member-specific quality factors accounted for 92, 54, and 87 percent of the variance in the overall quality measures for the Army, Air Force, and Marine Corps, respectively, with AFQT score accounting for the remainder.<sup>4</sup> Hosek and Mattock (2002) found that the AFQT scores of those members who decided to stay in the military at the end of their first term tended to be lower than those who left. That is, the military tended to retain lower-quality personnel when quality was measured in terms of AFQT. However, they found the opposite result when quality was measured in terms of the broader Ward-Tan quality definition: members who stay at the end of their first term tend to be of higher quality than those who leave. This report extends Hosek and Mattock's analysis (2002) into the midcareer.

In a related study, Hosek et al. (2004) studied the military's success in recruiting and retaining high-quality personnel in the information technology (IT) fields in the 1990s, a time when demand for such personnel in the private sector was at a peak. Using data from 1993 through 2001, they find that contrary to reports in the media in the 1990s, the services were able to attract high-quality personnel in the IT occupations, were able to maintain lower attrition rates and induce some of them to select longer terms of service than personnel in non-IT occupations, and were able to maintain generally comparable retention rates. Hosek and Mattock (2002) argue that an important factor explaining the attractiveness of the military for IT personnel is the value and transferability of IT to civilian jobs.

In summary, these studies generally conclude that the AFQT scores of those who reenlist at the end of the first term are roughly equal to or somewhat less than those of personnel who leave, when quality is measured by AFQT score and promotion opportunities are not taken into account in the analysis. When quality is measured more broadly, as in the Ward-Tan study or the Hosek-Mattock analysis, high-quality personnel are found to be more likely to stay in service. Furthermore, when promotion opportunities are held constant, as in the Buddin et al. (1992) study, those with higher AFQT scores are found to be more likely to leave.

## Approach and Organization of This Monograph

The approach in this monograph builds on these previous studies, especially the Ward-Tan and Hosek-Mattock studies. We describe empirically the recruitment, attrition, retention, and promotion outcomes of high-quality personnel. We contribute to existing knowledge about the relationship between quality and outcomes with our focus not only on personnel quality during the first term of enlistment but also through the midcareer, to YOS 12. We consider outcomes in each service and broad, one-digit occupational areas in the case of

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<sup>4</sup> No estimate is available for the Navy because the Navy's promotion process occurs in six-month intervals, and personnel of different quality are more likely to be lumped together. The discontinuous nature of Navy promotions makes it difficult to identify unobserved quality from the information on promotion speed to E-4 and E-5.

AFQT scores and education. For the quality index, we present outcomes for selected three-digit DoD occupational codes. Our data cover the period from 1978 to 1996 and therefore provide information on much of the All-Volunteer Force years up until the post-defense drawdown years. As in the Hosek-Mattock study, we apply the Ward-Tan model and define personnel quality in terms of not only entry quality such as AFQT scores and education but also the broader quality measure developed and used by Ward and Tan.

This monograph is organized as follows. The next chapter presents an overview of the measures of personnel quality that we use. Chapter Three presents the results on the quality of personnel in the first term, including the quality of those retained at the first reenlistment point. Chapter Four discusses our results concerning retention and promotion of high-quality personnel beyond the first term. We present our conclusions in Chapter Five.



## Measuring Personnel Quality

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This chapter briefly describes the quality measures and the data we use in our analysis. In addition to the usual quality measures of education and AFQT scores, we use a broader measure developed by Ward and Tan (1985) and recently applied by Hosek and Mattock (2002). We use the same data as the Hosek and Mattock analysis.

### Measures of Personnel Quality

The traditional measures of personnel quality are entry-level education, specifically whether the enlistee is a high school diploma graduate, and the individual's score on the AFQT. An enlistee is considered high quality if he or she is a high school diploma graduate and has an AFQT score that is in the top half of its distribution, i.e., if it is 50 or above. The AFQT is a composite of four of the subtests of the ten-part ASVAB administered to all recruits prior to enlistment. The test was designed to predict success in training and on-the-job performance, and extensive evidence from the JPM Project, a DoD-sponsored study conducted in the 1980s and early 1990s, shows a strong relationship between AFQT and job performance measured in terms of scores on hands-on tests of performance in a range of work samples for a variety of military skills (Wigdor and Green, 1991; Mayberry and Carey, 1997). Research for the Army's portion of the JPM project has shown a relationship between AFQT score and metrics of effort and leadership (Oppler et al., 2001). Other studies have also found evidence that those with higher AFQT scores perform better on combat-related tasks (Orvis, Childress, and Polich, 1992). As for education, those with a high school diploma are more likely to fulfill their service obligation (Buddin, 1988; Warner and Solon, 1991). A clear advantage of high school diploma status and AFQT score is that they are available to the military before enlistment, and therefore before expensive recruiting and training costs have been incurred. Thus, they provide excellent sources of information for screening military applicants and sorting them into jobs.

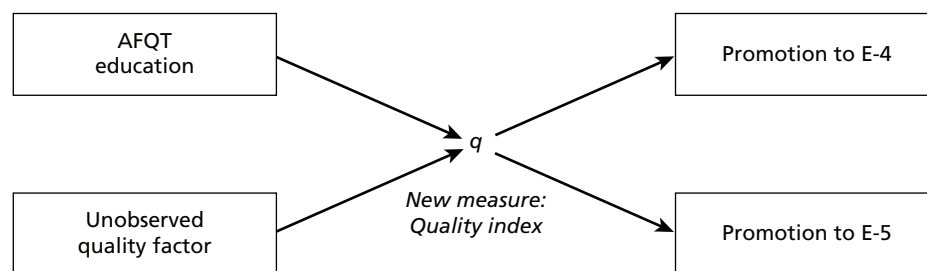
While these entry-level measures are correlates of performance, usually holding time in service fixed, additional information about personnel quality may be revealed over time and only on the job. Mayberry and Carey (1997) note that the hands-on tests of performance administered as part of their analysis of Marine Corps performance for the JPM project did not measure a Marine's ability to lead, to operate in stressful situations, or to work effectively in teams. That is, some aspects of job performance, including suitability for the military lifestyle, taste for service, as well as ability to perform well, may only become known to the member and the military with time, as the member has a chance to experience the military and perform in his or her job. This information is incorporated in the promotion proc-

ess to the extent that the military's promotion system evaluates members on the basis of their skills, knowledge performance, and goodness of fit. Those who are promoted faster on a consistent basis may thus be revealed to be higher quality.

Therefore, in our framework, personnel quality will depend on a variety of personal attributes. Such characteristics include general ability, effort, military-specific skills, leadership, the ability to work in teams, and taste for military service. While some of these characteristics are innate (e.g., ability), personnel exercise some control over others, such as effort. Furthermore, members may make such decisions mindful of their innate attributes, their taste for military service, and the opportunities the military provides. For example, a high-ability member may supply less effort than a low-ability member because good opportunities are available in the civilian sector. Yet a high-ability member with a personal preference for military service may be willing to work harder than a low-ability member with a weaker attachment to the military. Similarly, the prospect of promotion in return for performance can give high-ability personnel an incentive to work harder (see Buddin et al. [1992], Asch and Warner [1994a]).

Ward and Tan developed a model to use information on promotion speed to create a new measure of quality of military personnel, called the "quality index," based on Goldberger's (1972) multiple-indicator, multiple-cause model. Hosek and Mattock (2002) discuss the Ward-Tan model and its application to our data in detail. The overall quality of the job match, as determined by ability, tastes, and effort, *causes* quality ( $q$ ), while quality is revealed or *indicated* by promotion speed to E-4 and E-5. That is, the model assumes that the determinants of the quality index also influence promotion speed to E-4 and E-5. As shown in Figure 2.1, which is based on Ward and Tan (1985, Figure 9) and reproduced from Hosek and Mattock (2002, Figure 4.1), quality is decomposed into a component that the military can predict based on personal characteristics observed at entry (such as AFQT or education) and an unobserved (at entry) quality factor that is revealed on the job.

**Figure 2.1**  
**Schematic Model of Quality**



SOURCE: Reproduced with permission from Hosek and Mattock (2002, Figure 4.1).

RAND MG324-2.1

## Modeling and Estimating the Quality Index

The quality index model has three equations.<sup>1</sup> The first two equations relate the probabilities that a member who has reached a particular time in grade is promoted to E-4 and E-5 to the member's quality index. The reason that members of identical quality  $q$  are generally promoted at different times in grade is that chance plays a role in the promotion process. The third equation decomposes the quality index  $q_i$  for member  $i$  into its components. Hosek and Mattock (2002) specify this relationship as follows:

$$q_i = \beta * AFQT_i + \varepsilon_i$$

in which  $\beta$  is a parameter measuring the quality that can be expected given a member's  $AFQT_i$  and  $\varepsilon_i$  is the unobserved (at entry) quality factor representing the portion of a member's quality revealed on the job.<sup>2</sup> It is important to emphasize that the direct effect of innate ability (as measured by  $AFQT$ ) on quality cannot be distinguished from its indirect effect on effort in this model.

Estimation of the quality model is a complex task because the analyst never observes either the quality index  $q_i$  or the quality factor  $\varepsilon_i$ . The first difficulty is addressed by substituting the equation that decomposes the quality index into the equations for the probabilities of promotion. The unobserved factor is dealt with by assuming that it is normally distributed with zero mean and unit variance across the relevant population. In this fashion, the quality model links members' observed promotion histories to their observed  $AFQT_i$  and a set of unknown parameters (including  $\beta$ ).

The model makes intuitive predictions about this link. A "fast tracker" has a higher quality index, all else equal. If  $AFQT$  score is positively correlated with quality, as determined by innate ability, tastes, and effort,  $\beta$  is positive. In this case a member with a relatively high  $AFQT$  score is promoted more quickly to both E-4 and E-5. Furthermore, promotion to E-4 and E-5 is faster for a member with a high unobserved quality factor, because the quality factor is assumed to be constant over the career. Thus, the size of the correlation in promotion speeds to E-4 and E-5, both before and after controlling for  $AFQT$  score, provides information on the weight that should be given to an observable entry characteristic versus the unobserved factor in determining the quality index.

The method of maximum likelihood (Amemiya, 1985) estimates the model's unknown parameters by matching the model's predictions to the observed data as closely as possible. In particular, the likelihood equations explicitly account for censoring with respect to a member's promotion history when he or she either reaches the end of the first term of

<sup>1</sup> The interested reader is referred to Hosek and Mattock (2002) for a comprehensive discussion of these issues.

<sup>2</sup> Hosek and Mattock (2002) do not find that education plays a role distinct from  $AFQT$  score in quality. This finding is not surprising for recent cohorts given their limited variation in high school diploma status because nearly all members have a high school diploma.

The persistence of the unobserved quality factor over time follows from an implicit assumption that it has been fully revealed to the military by the time in service at which members begin to be promoted to E-4. Extending the model to allow for continual revelation of quality over a member's career may be a useful area for future research.

enlistment or exits from service prior to its completion. The model does assume that attrition is independent of the quality index.<sup>3</sup>

Once the quality model has been estimated, we compute the expected quality of members on the basis of the model and its recovered parameters. At the moment of entry, the analyst's (and the military's) best guess is that members' unobserved quality factors are identical. Therefore, differences in the quality index among members at the moment of entry will be attributable to different AFQT scores. As members progress through their first terms, more and more are promoted first to E-4 and then to E-5. The relative speeds with which members are promoted reveal information about their unobserved quality factors and thus quality indices. Beliefs are continually revised (according to Bayes' law) and become better informed as each member continues in service.

In subsequent sections, we present results on personnel entry, attrition, retention, and promotion using three measures of quality. The first two are the traditional measures of AFQT score and education. The third is the quality index, based on a subset of Hosek and Mattock's (2002) results for three-digit military occupational specialties (MOSs) in the Army, Marine Corps, and Air Force.<sup>4</sup> We also present the results using the quality index, but decomposed to show the part attributable to AFQT, that is  $\beta$ AFQT, where we use estimates of  $\beta$  from Hosek and Mattock.

The quality index has some potential weaknesses. This measure is reliable only if the Ward-Tan model is valid. While the fundamental assumption that promotion reveals information about the quality of job match is plausible, the quality index has not been validated with objective measures of military performance. Such an analysis would be a useful extension of the present research.

Next, a sufficient number of personnel must be promoted to E-5 before the end of the first term. Otherwise, there is insufficient information to determine whether faster than average promotion speed to E-4 is due to luck or to being a fast tracker. Next, the quality index is not available for Navy personnel. Promotions to E-4 and E-5 are done at six-month intervals in this service. This lumpiness in the promotion process means there is little information in observed promotion speeds, and the quality model cannot be estimated.

A final limitation is that, in contrast with AFQT score and high school diploma status, the quality indices of individuals in different groups (defined by entry cohorts, services, and occupational areas) cannot be directly compared on the basis of existing methods. The reason is that the model assumes that promotion opportunities must be fixed. Because promotion opportunities may vary in these dimensions, a distinct analysis must be con-

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<sup>3</sup> Warner and Solon (1991) find that members in the top half of the AFQT distribution are slightly more likely to complete their first terms. As AFQT scores and first-term completion become more strongly correlated, the importance of the quality index in the promotion process will tend to be understated when attrition is wrongly assumed to be random. Our focus here is on the degree to which quality is revealed on the job. If  $\beta$  is positive (as found in Ward and Tan [1985] and Hosek and Mattock [2002]), on-the-job revelation of quality becomes more important as  $\beta$  declines toward zero. Yet  $\beta$  is not necessarily biased in any direction when AFQT score and attrition are correlated. Furthermore, the large role for on-the-job revelation that researchers have found seems unlikely to be entirely an artifact of such correlation. Additionally, our finding that the two components of the quality index are not strongly negatively correlated with respect to retention and promotion into the midcareer suggests that we can draw unambiguous conclusions about whether the military manages to select for quality. Lastly, note that a relationship between AFQT scores and retention and promotion in the second term is not problematic, because the data set with which the model is estimated includes only the first term. Extending the quality model to include further revelations about quality in the second term would require a joint model of quality, retention, and promotion.

<sup>4</sup> The model's parameters vary freely across cohort, service, and occupation area.

ducted for each group.<sup>5</sup> Intuitively, then, we cannot learn anything from these distinct analyses about quality across groups.

As a concrete example of this limitation, suppose that individuals with relatively high quality indices tend to reenlist in occupational areas A and B but not in C. While we know that reenlistees in area C are lower quality than personnel in area C who separate, we cannot conclude that reenlistees in area C are lower quality than those in areas A and B. This limitation of the existing methodology is significant enough to justify further development of the framework.<sup>6</sup> We do emphasize, however, that the quality of personnel within each group can be compared over the course of their military careers. In particular, we can and do assess whether the military is consistently successful in absolute (if not relative) terms, i.e., across entry cohorts, services, and occupational areas.

Against these drawbacks the strength of the quality index is that quality revealed on the job can be inferred. Hosek and Mattock (2002) conclude that factors that are unobserved at entry generally account for the majority of the variance in personnel quality. The quality index is thus potentially more informative than the traditional entry-level measures.

## Data

Our analysis of personnel quality uses longitudinal data provided by the DMDC. These data, called the DMDC Special Cohort Accession and Continuer (DSCAC) file, track through FY96 the careers of enlisted personnel who entered active duty in a given fiscal year. Each fiscal year entry group defines an entry cohort. Our analysis file includes entry cohorts from FY78 through FY92. For each cohort, the DSCAC data provide entry (i.e., Military Entrance Processing Command [MEPCOM]) information, loss information, and either quarterly or semiannual information on each individual's active duty career. The entry information includes AFQT score, education at entry, race and ethnicity, occupation, age, and gender. The loss information, if relevant, includes occupation, type of separation, education, and marital and dependent status. The active duty information includes occupation, pay grade, promotion date for current grade, education, and marital and dependent status.

Several variables were created using the information provided in the DSCAC files. First, for each cohort we created variables indicating the number of months an individual took to get a promotion to each grade. If the individual did not get a promotion to a given grade, variables were created that indicated that this was the case. These time-to-promotion variables are used to estimate the quality index. Second, we created an attrition variable indicating whether an individual left before the completion of his or her first enlistment term. Third, we created variables to indicate whether an individual reenlisted, extended, or left at the end of his first enlistment term. These variables are used to analyze how personnel quality varies among individuals who enter, attrite, reenlist, or extend at the end of their first enlistment terms.

Finally, we created variables to indicate the individual's grade, occupation, and education at different points in his or her career. We use these variables to analyze how person-

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<sup>5</sup> As we discuss in Chapter Four, focusing within three-digit occupations does not solve this problem if there is migration among occupations and if differences in promotion opportunities somehow arise from differences in entry occupation.

<sup>6</sup> Hosek and Mattock (2002, Appendix A) discuss this issue and refinements that would make such comparisons possible.

nel quality is retained and promoted over the course of an individual's early and midcareer. We focus on outcomes as of YOS 0, YOS 4, YOS 8, and YOS 12. These four-year intervals roughly correspond to the first, second, and subsequent reenlistment points. While quality could have been examined at each YOS, our approach greatly simplifies the analysis and exposition. We believe that a fuller analysis is unlikely to change our qualitative conclusions.

We focus on the 90 to 95 percent of accessions who joined without prior service. Doing so simplifies the analysis and exposition. Quality, attrition and reenlistment behavior, and promotion tempo may have been related to prior-service status. The quality of prior-service personnel was plausibly more homogeneous (and higher) than that of non-prior-service personnel. Variation in the fraction of personnel who enter with prior service would confound our analysis of non-prior-service personnel. Hosek and Mattock (2002) also exclude prior-service personnel in their empirical specification of the Ward-Tan quality model.

Our analysis is conducted at the level of entry cohort (i.e., fiscal year of accession), service, and occupational area. For AFQT score and education, occupational area is defined by one-digit DoD occupational codes. This definition is narrow enough for a detailed comparison of occupational areas without becoming unmanageable. Table 2.1 gives these occupational code definitions. Since there are no medical or dental specialists (occupational code 3) in the Marine Corps, this occupational area is excluded in the analysis of Marine Corps outcomes.

**Table 2.1**  
**One-Digit DoD Occupational Code Definitions**

Code	Occupation
0	Infantry, gun crews, and seamanship
1	Electronic equipment repairers
2	Communications and intelligence
3	Medical and dental specialists
4	Other technical and allied specialists
5	Functional support and administration
6	Electrical/mechanical equipment repairers
7	Craftsmen
8	Service and supply handlers

SOURCE: DoD (1989).

In the analysis of the quality index, occupational area is defined by three-digit DoD occupational specialty. Hosek and Mattock (2002) observe that promotion opportunities may vary so much within one-digit occupations that a broader definition of occupational area is problematic.

To keep matters simple, our analysis of the quality index focuses on one three-digit occupation area for each service (excluding the Navy, for which results are unavailable). As Table 2.2 indicates, these occupational areas include missile artillery (occupation 043) for the Army, supply administration (occupation 551) for the Marine Corps, and general aircraft repair (occupation 600) for the Air Force.

**Table 2.2**  
**DoD Occupational Specialties in Analysis of Quality Index, by Service**

Service	DoD Code	Occupation
Army	043	Missile Artillery, Operating Crew
Marine Corps	551	Supply Administration
Air Force	600	Aircraft, General

SOURCE: DoD (1989).

These areas were chosen for several reasons. We considered the importance of each area to its relevant service's mission. Relatively large fractions of personnel within each service enlisted in these areas. Within our data set, 4.2 percent of Army personnel began in missile artillery, 11.9 percent of Marine Corps personnel began in supply administration, and 23.1 percent of Air Force personnel began in general aircraft repair. Furthermore, the experience mix of aircraft maintainers, for instance, has become a serious concern in recent years (Dahlman, Kerchner, and Thaler, 2002). We also sought to include a group of occupational areas that varied in their general level of skill from relatively low (missile artillery) to relatively high (aircraft repair). Lastly, we chose areas for which results across cohorts were relatively available, because the index could not be successfully estimated in a substantial number of cases. We narrowed the analysis to FY80, FY84, FY88, and FY92 in order to compare areas on this basis. This criterion conflicted to some extent with the others. For example, results were not available for the FY92 cohort for the Army.

Table 2.3 characterizes promotion within the first term among personnel in these areas. More than 60 percent of personnel in each area reached E-4 before completing the first term (or exiting from service.) The mean number of months to E-4 ranged from 21 in missile artillery in the Army to 34 in general aircraft repair in the Air Force. Eleven percent of these Army E-4s were promoted to E-5, but only three percent of the Air Force E-4s were promoted. The times to promotion among personnel reaching both E-4 and E-5 are most informative about quality as revealed on the job. Table 2.3 indicates that such information is available for a small fraction of our sample. This limited information can still be of substantial value in an assessment of quality and retention and promotion into the midcareer. We now turn to this issue.

**Table 2.3**  
**First-Term Promotion**

Service Personnel	Promoted to E-4 (%)	Mean Months to E-4 Among E-4s	E-4s Promoted to E-5 (%)	Mean Months to E-5 Among E-5s
Army 043	68.2	21.1	11.4	18.0
Marine Corps 551	63.3	30.6	3.0	20.0
Air Force 600	76.7	34.2	8.0	17.0

NOTES: These statistics include personnel in all cohorts among FY80, FY84, FY88, and FY92 for which the quality index is available. Results were not available for the Marine Corps in FY80, or for the Army and Air Force in FY92.



## Personnel Quality in the First Term

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A major trend in defense manpower since 1980 has been the dramatic improvement in the quality of personnel entering the armed services. This chapter briefly describes this trend and examines whether the high-quality personnel who were drawn into military service at the entry point were retained by the services through the end of the first enlistment term. The next chapter describes retention and sorting outcomes beyond the first term. Appendix A complements this chapter with a comprehensive examination of trends in first-term reenlistment and retention for our data on entry cohorts from FY78 to FY92.

### Trends in Entry Quality

The quality of entrants into the military, as revealed by traditional measures, was particularly low in the late 1970s and in 1980.<sup>1</sup> In 1980, the fraction of military entrants with a high school diploma was 66 percent (Table 3.2), and the fraction that scored in the top half of the AFQT score distribution was 38 percent (Table 3.1).<sup>2</sup> The percent that were high quality, i.e., high school graduates with AFQT scores in the top half of the distribution, was 35 percent. The problem was particularly acute in the Army, where the fraction of recruits who were high quality was 21 percent in 1980.

In part, the low quality of recruits during this time period reflected the 1980 misnorming of the ASVAB. In part, it reflected the low value of military compensation relative to civilian compensation. In 1981 and 1982, military pay was increased substantially, by an average of 11.7 percent in fiscal year 1981 and by 14.3 percent in FY82. In addition, the Army implemented several programs during the early and mid-1980s intended to improve recruit quality. These included the introduction of the Army College Fund and the expansion of the enlistment bonus program in 1985. In addition, the management of recruiting became more sophisticated in terms of motivating recruiters through incentive plans and developing advertising campaigns that effectively targeted the young adult population.

By 1986, entry quality rose substantially relative to 1980. Table 3.1 shows the percent of non-prior-service accessions in DoD and in each service that scored in the top half of the AFQT distribution from FY78 through FY04. Table 3.2 shows the fraction of accessions that were high school graduates for these years. In FY78, only 43 percent of DoD accessions without prior military experience scored in the upper half of the AFQT test score distribu-

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<sup>1</sup> The broader quality index is not comparable across entry cohorts.

<sup>2</sup> The summary statistics on the quality of military entrants presented in this chapter are derived from our DSCAC analysis file, from DoD (2004), and from statistics provided by the Office of Accession Policy, Office of the Secretary of Defense.

tion, and the figure was as low as 31 percent for the Army. By FY86, the figure rose to 64 percent of DoD accessions. The corresponding figures were 63, 58, 65, and 71 percent for the Army, Navy, Marine Corps, and Air Force, respectively. The fraction that were high school diploma graduates was 92 percent for all DoD accessions in FY86 and was 91, 90, and 99 percent for the Army, Marine Corps, and Air Force. Only the Navy fell below 90 percent and had 85 percent high school diploma graduates. Consequently, high-quality recruits accounted for 57 percent of all DoD non-prior-service accessions in 1986.

**Table 3.1**  
Percent of Non-Prior-Service DoD and Army Accessions in Top Half of AFQT Score Distribution

Entry Cohort	DoD	Army	Navy	Marine Corps	Air Force
78*	43	31	52	40	59
79*	39	25	49	37	55
80*	38	22	51	39	55
81	48	34	55	49	60
82	52	46	56	50	61
83	58	53	61	54	68
84	58	54	60	52	71
85	62	61	61	55	69
86	64	63	58	65	71
87	67	67	81	68	77
88	67	65	81	68	84
89	64	62	57	67	84
90	68	67	62	66	84
91	75	80	66	69	85
92	74	78	68	71	86
93	71	70	70	68	80
94	72	71	68	71	81
95	71	69	66	66	84
96	69	67	66	65	83
97	69	68	66	65	79
98	68	68	64	64	78
99	66	63	65	64	76
00	66	65	64	64	73
01	66	65	63	65	75
02	70	70	65	67	76
03	72	73	66	69	81
04	73	72	66	69	81

SOURCE: Office of Accession Policy, Under Secretary of Defense (Personnel and Readiness).

NOTE: \* indicates years when ASVAB misnorming occurred.

**Table 3.2**  
**Percent of Non–Prior-Service Accessions with High School Diploma or More**

Entry Cohort	DoD	Army	Navy	Marine Corps	Air Force
78	75	73	73	70	86
79	72	64	74	73	84
80	66	52	74	70	84
81	81	80	76	74	89
82	86	86	78	78	94
83	91	88	91	85	98
84	94	91	92	89	99
85	93	91	88	90	99
86	92	91	85	90	99
87	93	91	91	90	99
88	93	93	91	95	99
89	92	90	87	95	99
90	95	95	90	93	99
91	97	98	94	96	99
92	99	100	96	97	99
93	95	95	92	96	99
94	96	95	93	95	99
95	96	96	93	95	99
96	96	95	91	95	99
97	94	90	95	95	99
98	94	90	94	96	99
99	93	90	88	95	99
00*	91	91*	89	95	99
01*	90	91*	89	96	99
02*	91	91*	91	97	99
03*	93	92*	94	98	99
04*	95	92*	96	97	99

SOURCE: Office of Accession Policy, Under Secretary of Defense (Personnel and Readiness).

NOTE: \* In 2000, the Army began the GED Plus experimental program that permits up to 4,000 non-high school graduates who score high on the AFQT and the Assessment of Individual Motivation Test. Because these individuals are not traditional high school diploma graduates, the fraction of Army accessions with a high school diploma fell below 90 percent beginning in 2000. The figures in the table exclude these enlistments.

Recruit quality peaked in 1991–1992 when virtually all DoD accessions were high school graduates and 75 percent were in the top half of the AFQT test score distribution. Although recruit aptitude declined somewhat between the early 1990s and 2001 for DoD (especially during the tight labor market of the late 1990s), the quality of recruits has increased recently, with over 70 percent scoring in the top half of the AFQT test score distribution in 2004.

### Quality of Stayers and Leavers in the First Term

The discussion that follows examines quality differences in those who attrite versus complete their first terms and those who reenlist versus separate at the end of their first terms. Attrition

is defined as an exit that occurs before the end of the individual's first term that is not a reenlistment, extension, or transfer to the officer corps as indicated by the interservice separation code on the DMDC data files. This definition of attrition is broad since it includes everyone who does not complete the first enlistment term. Past studies (e.g., Buddin, 1984) have often focused on attrition early in service, such as the first three or six months, since most attrition occurs during this period. As discussed in past studies (Klein, Hawes-Dawson, and Martin, 1991; Buddin, 1984, 1988; Warner and Solon, 1991), individuals attrite from service for a variety of reasons, including medical and disciplinary problems.

This definition of attrition captures exits that occur over an extended time period, e.g., over five years for those who enlist for six years. Therefore, although we define cohorts by their entry year, say FY90, the outcomes that we are measuring can occur more than five years after that date. Similarly, we associate retention rates with each entry cohort. Since retention at the end of the first term may occur as many as six years or as few as two years beyond the entry date, the retention outcomes we measure can occur well beyond the entry date. Thus, for the FY90 entry cohort, attrition and retention may occur through or at the end of FY96 in some cases. While attrition and retention rates are defined relative to the size of the cohort at entry, the reenlistment rate is defined relative to those who do not attrite. That is, the reenlistment rate is defined as the fraction of those individuals who complete the first term (i.e., do not attrite) and who reenlist. Personnel who extend their first terms prior and then reenlist are included.

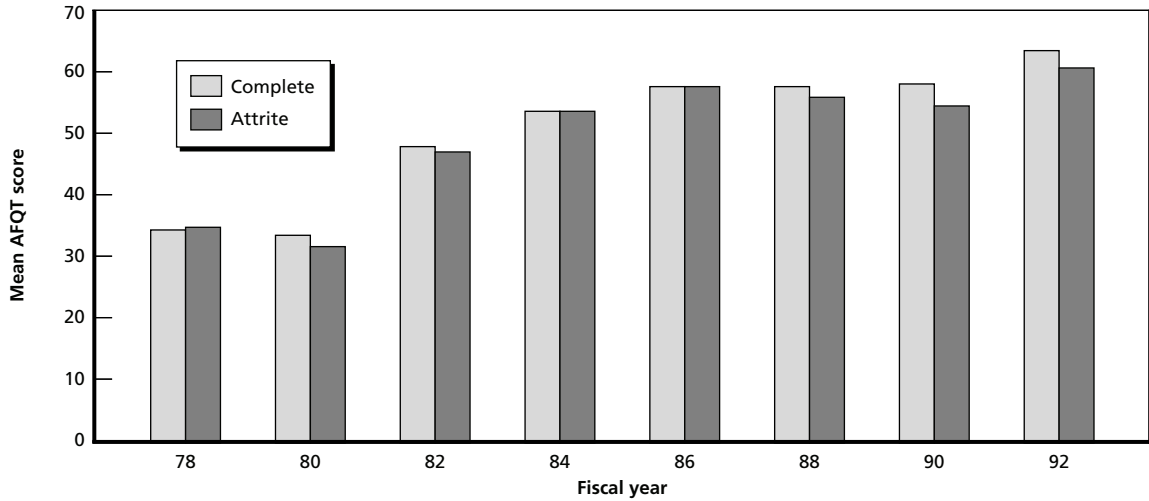
We use three measures of personnel quality in our comparisons: AFQT score, education, and the quality index. The first two measures are entry characteristics. In the case of education, we focus on the fraction of individuals who have a high school diploma or more education. Because the quality index is estimated at the level of the three-digit DoD occupational area, we report results for occupation 043 (missile artillery) in the Army, occupation 551 (supply administration) in the Marine Corps, and occupation 600 (general aircraft repair) in the Air Force.

### **Quality Differences of Those Who Attrite Versus Complete Their First Terms**

To examine quality differences of those who complete their first terms versus attrite, we subtract the average quality of those who attrite from the average quality of those who complete their terms. Our focus throughout this report is on comparisons of average quality, because existing methods estimate the average level of the quality index for each member (Hosek and Mattock, 2002). Nevertheless, other differences (e.g., in attrition among personnel who are above average in quality, however measured) are plausibly important to policymakers. A broader assessment could be a useful direction for future research.

To illustrate how we compare quality, Figure 3.1a shows the mean AFQT score by entry cohort (i.e., year of accession) of those who completed their term versus attrited in occupational area 0 in the Army. The differences between the two averages are shown in Figure 3.1b. Subsequent figures illustrate these differences for AFQT scores and education for different entry cohorts, services, and occupational areas.

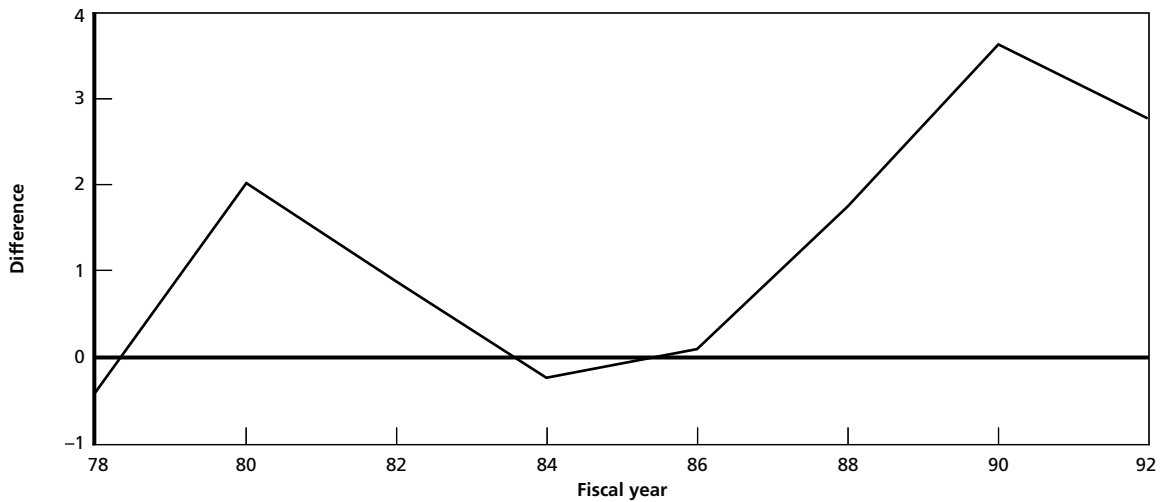
**Figure 3.1a**  
**Army Infantry, Gun Crew (Occupation Code 0), Mean AFQT Scores by Cohort Entry Year**



SOURCE: Authors' calculations using the Defense Manpower Data Center (DMDC) Defense Special Cohort Accession Continuer (DSCAC) file.

RAND MG324-3.1a

**Figure 3.1b**  
**Army Infantry, Gun Crew (Occupation Code 0), Differences in Mean AFQT Scores by Cohort Entry Year**



SOURCE: Authors' calculations using the DMDC DSCAC file.

RAND MG324-3.1b

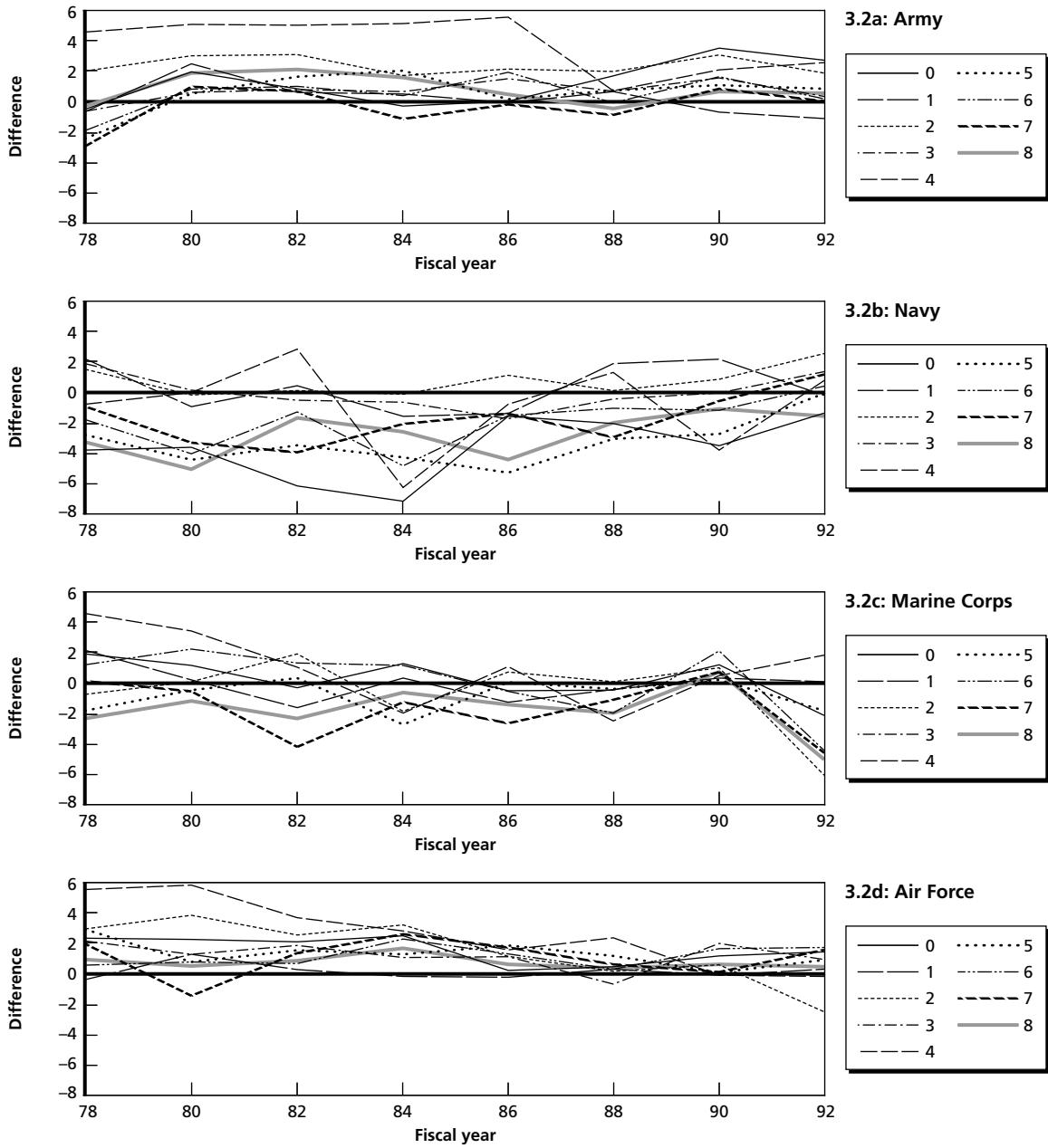
Figures 3.2a, 3.2b, 3.2c, and 3.2d show that the mean AFQT scores of those who complete their first terms have been somewhat higher than the scores of those who do not in the Army and Air Force, especially for DoD occupational group 4 (other technical and allied specialists) in which the difference is as high as six points for the earlier entry cohorts. These completers are slightly higher quality than attriters, when AFQT score is the quality measure. In contrast, those who attrited from the Navy tended to have higher mean AFQT scores than those who completed their first term. The differences have also tended to be negative but relatively small for the Marine Corps. Differences for the various groups tended to range

from about two to four points in magnitude for most occupational areas through the FY84 cohort. By the FY92 cohort, those who attrited in the various occupational groups tended to have mean AFQT scores that were between two points higher and two points lower than those who completed their first terms. These results are generally consistent with studies that have found that AFQT score has a small effect on the probability that an individual attrites from service (e.g., Buddin, 1984).

While these differences are generally statistically significant, their significance for policymakers turns on the benefit and cost of personnel quality. These fundamentals may vary across services, occupational areas, and entry cohort. For example, quality differences may have become more important as the military has come to rely more heavily on advanced technology. Our results can contribute to an examination of quality outcomes that incorporates these varying fundamentals. In narrower terms, the magnitudes of these differences in AFQT scores (within as well as across groups) are muted relative to those evident for other outcomes, such as promotion through the midcareer.

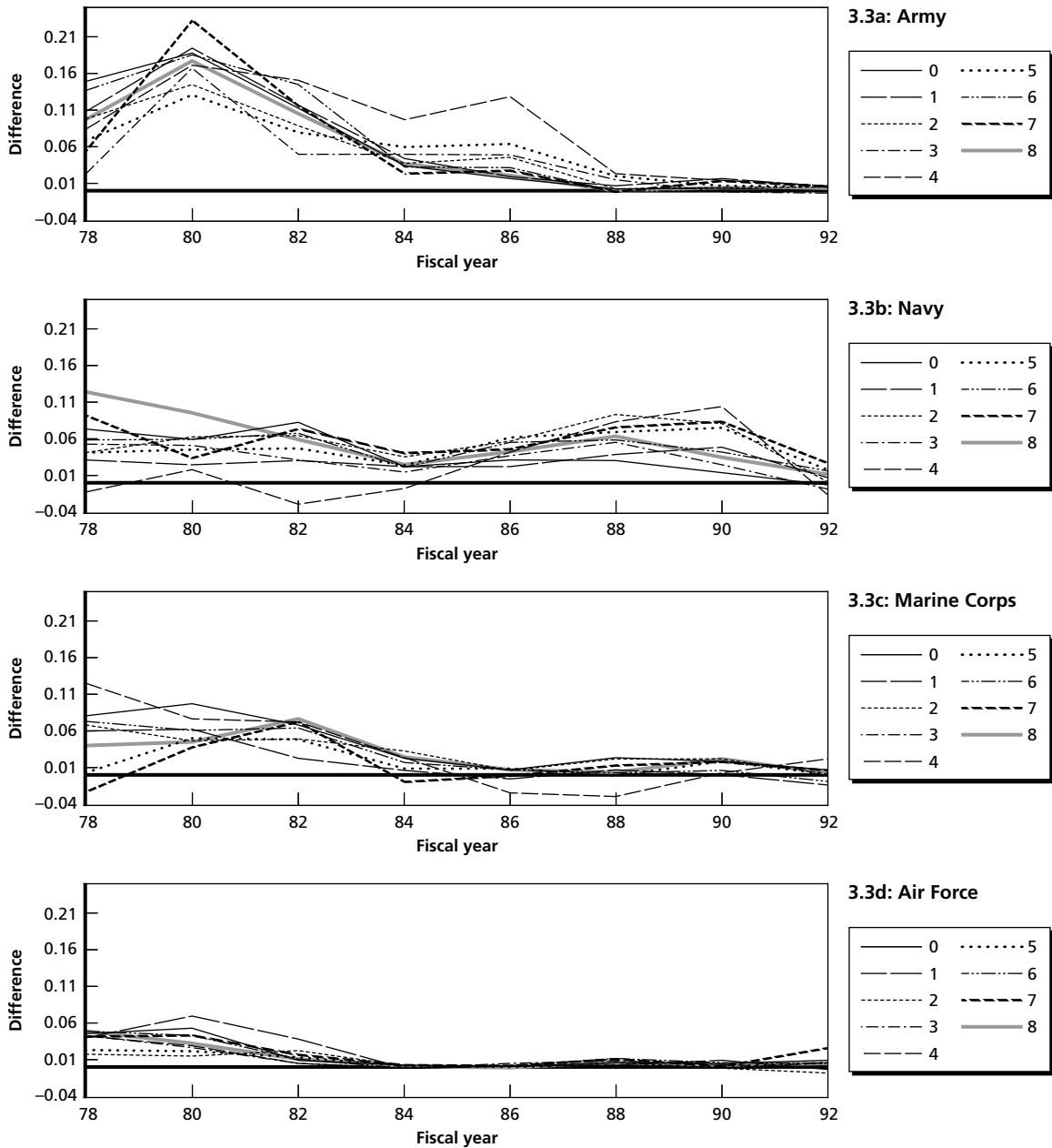
Figures 3.3a through 3.3d illustrate the differences in the fraction of individuals with a high school diploma among those who complete versus attrite. Again, consistent with past studies, we find that those with a high school diploma are less likely to attrite during the first term. The positive difference in the percent with a high school diploma among those who complete and those who attrite is particularly great among those cohorts entering the Army in the late 1970s and early 1980s. For example, among those entering the Army infantry occupational area (DoD occupation area 0) in FY78, 74 percent of those who completed their first terms, but 59 percent of those who attrited were high school graduates, a difference of 15 percentage points. By FY92, the differences in the educational attainment of those who attrite and those who complete their first terms diminishes. Indeed, for the Air Force, the difference is nearly zero. In large part, this trend and the minor differences observed for the Air Force reflect the fact that by the FY86 cohort, over 90 percent of recruits were high school graduates. Consequently, less variation is possible in the relative educational attainment of completers and attriters.

**Figure 3.2**  
**Differences in Mean AFQT Scores, Complete Minus Attrite, by Service, Entry Cohort, and One-Digit Occupation**



SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas.  
 RAND MG324-3.2

**Figure 3.3**  
**Differences in Fraction with High School Diploma or More, Complete Minus Attrite, by Service, Entry Cohort, and One-Digit Occupation**



SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas.  
 RAND MG324-3.3

Table 3.3 reports differences in the mean quality index between completers and attriters for the service-specific, three-digit occupations listed in Table 2.2. As we discussed in Chapter Two, this index incorporates quality that could not be observed at entry but was revealed on the job ( $\epsilon$ ) as well as the quality observed at entry, i.e., AFQT score. We

**Table 3.3**  
**Differences in Mean Overall Quality Index and Contribution of AFQT Score, Complete Minus Attrite, by Service, Three-Digit Occupation Code, and Entry Cohort**

Entry Cohort	Service and DoD Occupational Specialty		
	Army 043	Marine Corps 551	Air Force 600
<b>Overall Quality Index (<math>q=\beta\text{AFQT}+\epsilon</math>)</b>			
80	+0.34	n/a	+0.15
84	+0.23	+0.23	+0.11
88	+0.23	+0.27	+0.03
92	n/a	-0.75	n/a
<b>Contribution of AFQT Score (<math>\beta\text{AFQT}</math>)</b>			
80	+0.01	n/a	-0.01
84	-0.04	-0.06	0.00
88	-0.05	-0.04	-0.02
92	n/a	-0.76	n/a

SOURCE: Authors' calculations using the DMDC DSCAC file.

NOTE: n/a indicates that the quality index is not available because estimation of the quality model did not yield reliable results for this service/occupation/entry-cohort group.

emphasize that the quality of attriters is also revealed to some extent, because some of these personnel remained in service long enough to have been “at risk” of promotion under our broad definition of attrition.

The results generally suggest that completers are revealed to be of higher quality. For example, the mean value of the (total) quality index for completers is +0.23 greater than the value for attriters among personnel in occupation 043 in the Army's FY84 entry cohort. The magnitude of differences in the quality index can be compared with the magnitude of the differences in AFQT in Figures 3.2a through 3.2d. AFQT score is converted into units of the quality index by applying the estimate of the group-specific parameter, the  $\beta$ 's, from Hosek and Mattock (2002).

Hosek and Mattock (2002) found that the parameter estimates for AFQT score were relatively small on average, indicating that observed quality had relatively little weight in explaining the quality index. Given the formula for converting AFQT score to comparable units, we report in the bottom panel in Table 3.3 the mean differences in the quality index arising from differences in AFQT scores. Consider again personnel in occupation 043 in the Army's FY84 cohort. The mean difference in the expected quality index resulting from AFQT scores is -0.04, indicating that completers in this group had slightly lower AFQT scores. Yet the total quality of completers is greater, because completers are so much better with respect to quality as revealed on the job ( $\epsilon$ ) as to dominate their inferiority in quality expected at entry ( $\beta\text{AFQT}$ ). Table 3.3 reveals a pattern in which AFQT score alone indicates that completers are slightly lower quality, while the total index indicates that completers are higher quality. The differences in the total quality index are much greater in magnitude than differences in expected quality due to AFQT score, whatever their signs. For example, the difference in average quality for supply administrators in the Marine Corp's FY88 cohort is almost seven times as large as AFQT scores alone would indicate.

For these three occupations, this more informative quality measure indicates that the military generally manages to keep high-quality personnel through the first term. Recall that the quality index cannot be directly compared across entry cohorts, services, and occupational areas, as the distinct format for the presentation of these results is intended to emphasize. Thus, while differences in AFQT scores between completers and attriters generally decline subsequent to the FY84 cohort, the contrast in the quality index for occupation 043 in the Army's FY84 cohort may in fact be larger than, smaller than, or equal to the contrast for its FY88 cohort. While we cannot compare the military's success across groups, we do emphasize that the military consistently keeps the high-quality personnel within groups, i.e., across entry cohorts, services, and occupational areas.

Supply administrators in the Marine Corp's FY92 cohort represent a consistent outlier in our analysis of the quality index. High-quality personnel in this group are more likely to attrite, to separate at the end of the first term, and not to be promoted. AFQT score accounts for almost all of the variation in quality for this group (Hosek and Mattock, 2002). Thus the quality index is relatively more sensitive to attrition by high-AFQT score personnel in this group. Consistent with this observation, the differences in the total and expected quality indices are virtually identical.

### Quality Differences at the End of the First Term

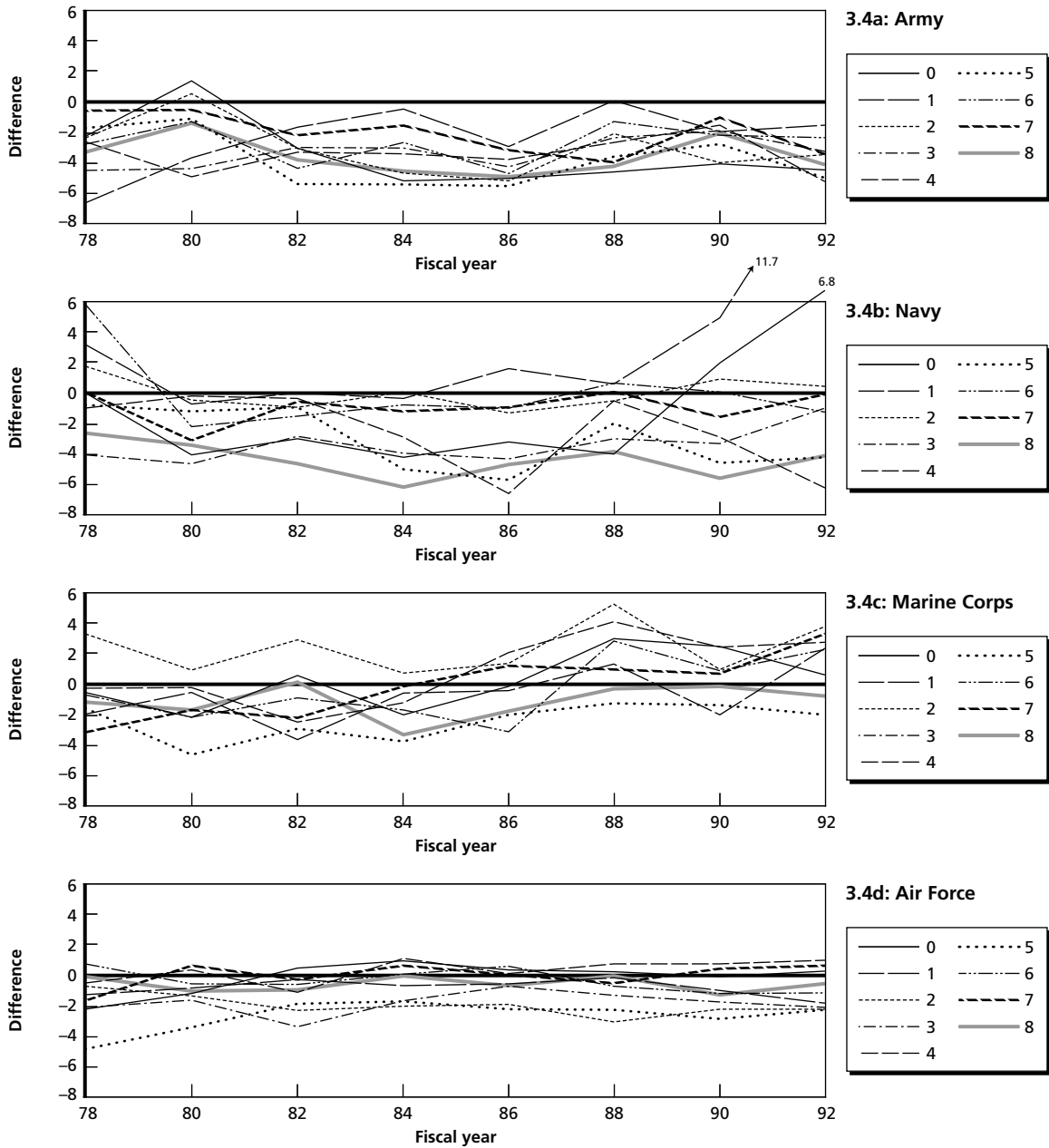
Figures 3.4 and 3.5 show the differences in average quality of those who reenlist versus separate at the end of their first terms using traditional measures of quality. Reenlistment is defined as opting to stay in the military at the end of the expiration of term of service (ETS) date either by signing a new enlistment contract or by extending the existing contract.

Figure 3.4 shows that, for the Army, the differences in the mean AFQT scores of those who separate and those who reenlist are generally negative. That is, those who leave the Army at the end of the first term are higher quality than those who reenlist when quality is measured in terms of mean AFQT score. The differences in means across occupational areas ranges from 0 to -4 points, with a few occupational areas and cohorts exhibiting a difference of -6 points. For the Navy, the differences are generally of a similar or somewhat greater magnitude than they are for the Army. As with the Army, they tend to be negative, implying that those who reenlist are generally lower quality than those who separate in terms of mean AFQT scores. A notable exception is occupational area 1, electronic equipment repairers, where the mean AFQT scores of those who reenlist is significantly greater than the mean AFQT scores of those who separate among recent cohorts.<sup>3</sup> The differences for the Army and Navy are similar in scale to the differences in AFQT scores between completers and attriters. Given that the standard deviation of AFQT scores is about 20 to 25 in the early cohorts and about 15 to 20 in the later cohorts, a difference of four points is about 0.16 to 0.27 standard deviations.

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<sup>3</sup> Indeed, the mean AFQT of reenlistees exceeds that of separatees by so much for this group that the scale of the panel for the Navy in Figures 3.4a through 3.4d is truncated, to facilitate comparisons across services.

**Figure 3.4**  
**Differences in Mean AFQT Scores, Reenlist Minus Separate at ETS, by Service, Entry Cohort, and One-Digit Occupation**



SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas.  
 RAND MG324-3.4

For the Air Force, we observe relatively small, negative differences in the mean AFQT scores of those who leave versus reenlist at the end of the first term. This result contrasts with the larger, positive differences between completers and attriters among early Air Force cohorts. In the Marine Corps, the mean AFQT scores of those who reenlist relative to those who separate has generally improved for cohorts entering after FY84. Among the FY84

cohort, the difference was either zero or negative in the majority of the occupational areas. Among the FY92 cohort, the difference was positive in all but two occupational areas. Despite the improvement over time across cohorts, the differences for the Marine Corps (about two points) are small relative to the standard deviation of AFQT scores, as was true of the differences between completers and attriters.

These results are generally consistent with previous studies that find a relatively small effect of AFQT scores on reenlistment (Ward and Tan, 1985; Smith, Sylwester, and Villa, 1991). Ward and Tan (1985) find a three- to four-point negative difference in the mean AFQT scores among the two Army occupations they analyzed in the FY78 cohort. They also found virtually no differences for the two Air Force occupations they studied and a two- to five-point negative difference for the Navy occupations. For the Marine Corps, they found a zero or positive difference.

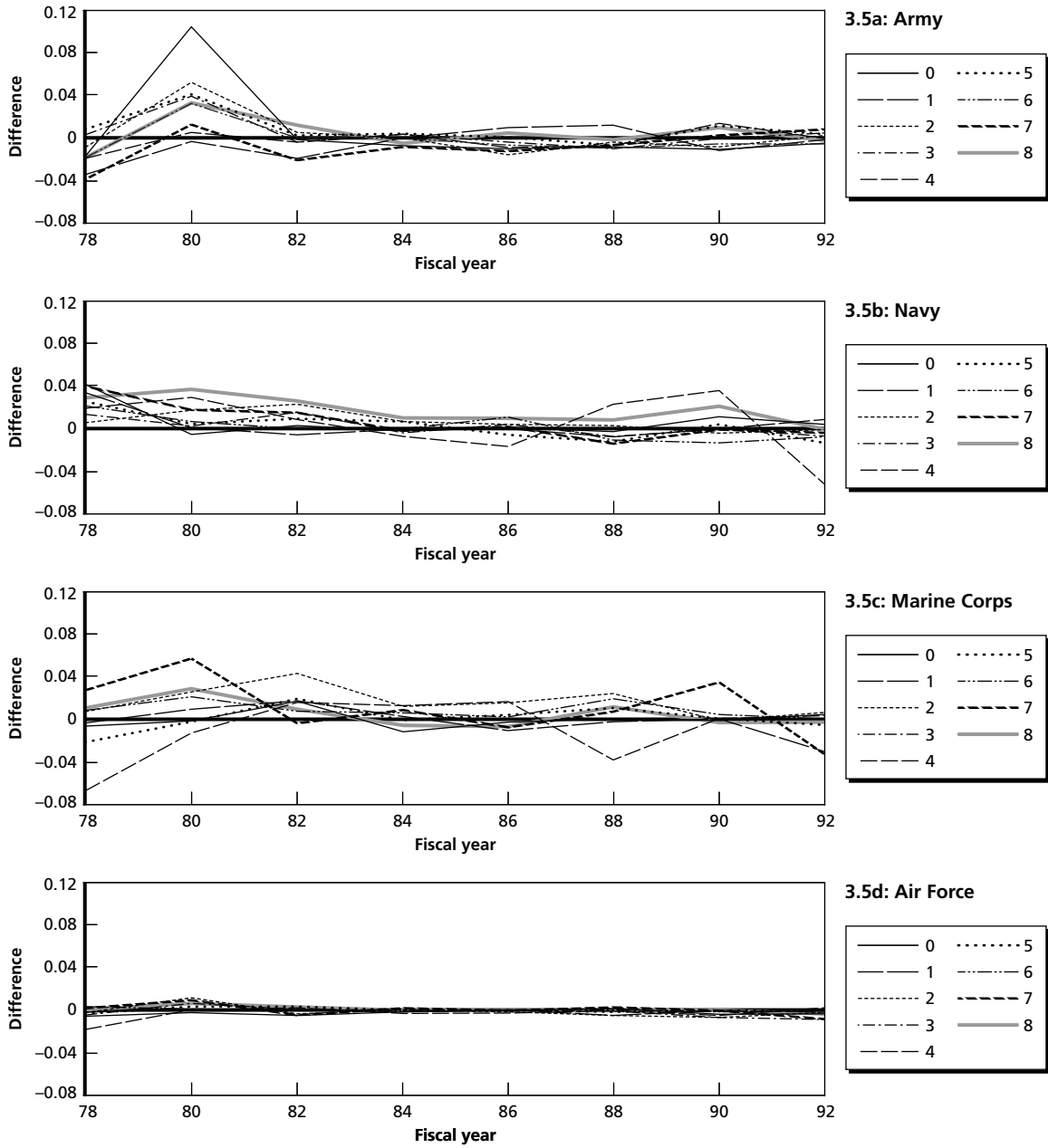
Relative to the attrition results in the early 1980s, differences in the educational attainment of those who reenlist versus separate at the end of their first term are small. As Figure 3.5 shows, even in the early 1980s, the differences in the fraction with high school or more were between four and six percentage points. Among later cohorts, the differences were even smaller.

Table 3.4 reports differences in the mean quality index between reenlistees and separatees for the three three-digit occupations. With the exception of supply administrators in the Marine Corp's FY92 cohort, members who stay beyond the first term are of substantially higher quality than those who leave. As in the analysis of attrition, the negative values in the lower panel in Table 3.4 indicate that we would draw the wrong conclusion based on AFQT alone. That is, given the positive values of  $q = \beta AFQT + \varepsilon$  in the top panel, it must be the case that  $\varepsilon$  must be sufficiently large to offset the negative values of  $\beta AFQT$  reported in the bottom panel. Thus, separation by personnel with somewhat higher mean quality due to AFQT within these groups is dominated by the reenlistment of personnel with superior mean quality attributable to factors revealed over time and on the job, given our assumption about the relationship between performance and promotion speed. The positive quality differential for first-term reenlistment is larger in magnitude than that for completion in the cases of occupation 043 in FY80, occupation 551 in FY88, and occupation 600 in all fiscal years. Thus, high-quality personnel may be selected more through reenlistment than completion.<sup>4</sup> In the next chapter, we examine differences in the three measures of quality beyond the first term.

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<sup>4</sup> The positive statistics in Table 3.4 constitute upper bounds on the degree to which the quality of reenlistees exceeds that of all completers, including separatees.

**Figure 3.5**  
**Differences in Fraction with High School Diploma or More, Reenlist Minus Separate at ETA, by Service, Entry Cohort, and One-Digit Occupation**



SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas.  
 RAND MG324-3.5

**Table 3.4**  
**Differences in Mean Overall Quality Index and Contribution of AFQT Scores, Reenlist Versus Separate at ETS, by Service, Three-Digit Occupation Code, and Entry Cohort**

Entry Cohort	Service and Occupation		
	Army 043	Marine Corps 551	Air Force 600
<b>Overall Quality Index (<math>q=\beta AFQT+\epsilon</math>)</b>			
80	+0.49	n/a	+0.29
84	+0.19	+0.28	+0.14
88	+0.26	+0.61	+0.09
92	n/a	-1.01	n/a
<b>Contribution of AFQT (<math>\beta AFQT</math>)</b>			
80	-0.02	n/a	-0.01
84	-0.07	-0.10	-0.07
88	-0.01	-0.03	-0.01
92	n/a	-1.02	n/a

SOURCE: Authors' calculations using the DMDC DSCAC file.

NOTE: n/a indicates that the quality index is not available because estimation of the quality model did not yield reliable results for this service/occupation/entry-cohort group.

## Retention and Promotion of High-Quality Personnel in the Early and Midcareer

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The previous chapter focused on the question of whether high-quality personnel were retained through the end of the first enlistment term. This chapter examines whether high-quality personnel are retained through their early and midcareers and promoted to the more senior grades. Just as Appendix A complemented the last chapter's analysis of quality through the first term, Appendix B provides a comprehensive examination of trends into the early and midcareer retention for our data set. As discussed elsewhere (Rosen, 1982, 1992; Asch and Warner, 1994b), it is desirable for a hierarchical organization like the military to place the most able personnel in the highest positions of management and leadership because their decisions are amplified throughout the organization and affect the productivity of workers in all lower ranks of the hierarchy. For the military, which has no lateral entry, the most able people must be identified, retained, and promoted from within the organization. Missteps at any point—poor identification, low retention, or nonpromotion—can reduce the efficiency of the entire organization, which for the military means less capability and lower readiness. Therefore, an important function of the military compensation and personnel systems is to identify high-quality personnel, induce them to stay, and promote them into senior grades.

Rather than examine the retention and promotion of high-quality personnel at every YOS for every cohort, we examine retention and promotion outcomes at YOS 0, YOS 4, YOS 8, and YOS 12 among cohorts that entered service in FY80, FY84, FY88, and FY92. This approach is unlikely to obscure important evidence. These YOS points roughly correspond with entry and first, second, and third reenlistment, respectively.<sup>1</sup> For the FY92 cohort, we can only examine retention and promotion outcomes at YOS 0 and YOS 4. Not enough time has elapsed between FY92 and FY96 to examine outcomes at YOS 8 and YOS 12 for this cohort; similarly, YOS 12 cannot be analyzed for the FY88 cohort. Although it would be feasible to examine outcomes beyond YOS 12 for the FY80 cohort, we stop at YOS 12 for simplicity. Since the vast majority of personnel who stay until YOS 12 stay until retirement, the results for YOS 12 should generally apply to later YOS in the midcareer.

Personnel may migrate between occupations, as their careers progress. If migration is substantial, an analysis of the midcareer may focus either on the occupations in which members begin their careers or on their occupations as these careers evolve. If one is concerned with retention and promotion within the military as a whole, these treatments of occupation are equivalent. If, however, quality within occupations is of interest (as is the case here), a

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<sup>1</sup> Our YOS variable accounts for breaks in service. For example, an individual who entered service in FY80 and left for a year in 1982 would reach YOS 4 in 1985, not 1984, like others in his or her cohort who did not have a break in service. However, only a small fraction of personnel have breaks, and the fraction with breaks as long as a year in our data is minute.

valid measure should account for migration of relatively low- or high-quality personnel into or out of particular occupations.

To assess the practical significance of the issue of migration, we examined the match rate of members' one-digit DoD occupational area at entry and at YOS 4, YOS 8, and YOS 12. We found that at YOS 4, the match rate was about 85 to 95 percent. That is, 85 to 95 percent of the entrants in a given one-digit occupational area and service were in the same one-digit occupational area at YOS 4 in our data. The match rate declined to 75 to 85 percent at YOS 8 and YOS 12. The exception is occupational area 0 (infantry, gun crew, and seamanship) for the Marine Corps and Air Force. For this group, the match rates at YOS 8 and YOS 12 were closer to 50 percent. Given the generally high match rates, we conclude that the treatment of occupation is generally unimportant. Because there is substantial migration for occupational area 0 for the Marine Corps and Air Force, our interest in quality within an occupation requires that members' occupations reflect any migration over the career. We therefore use current occupation in all our analyses of AFQT and education.

In the case of the quality index, Hosek and Mattock (2002) define groups on the basis of the three-digit DoD occupation in which members began service. The quality index is defined in terms of entry year, service, and, entry occupation because promotion speeds differ by service, entry cohort, and occupation. The opportunity to migrate among three-digit occupations is fairly limited through the end of the first enlistment term, which was the focus of their report. Though the opportunity for migration is certainly greater beyond the first term, we follow their convention and use entry occupation rather than current occupation. Thus, the reference point in comparing the quality index across members will be service members' peers in their entry occupations.

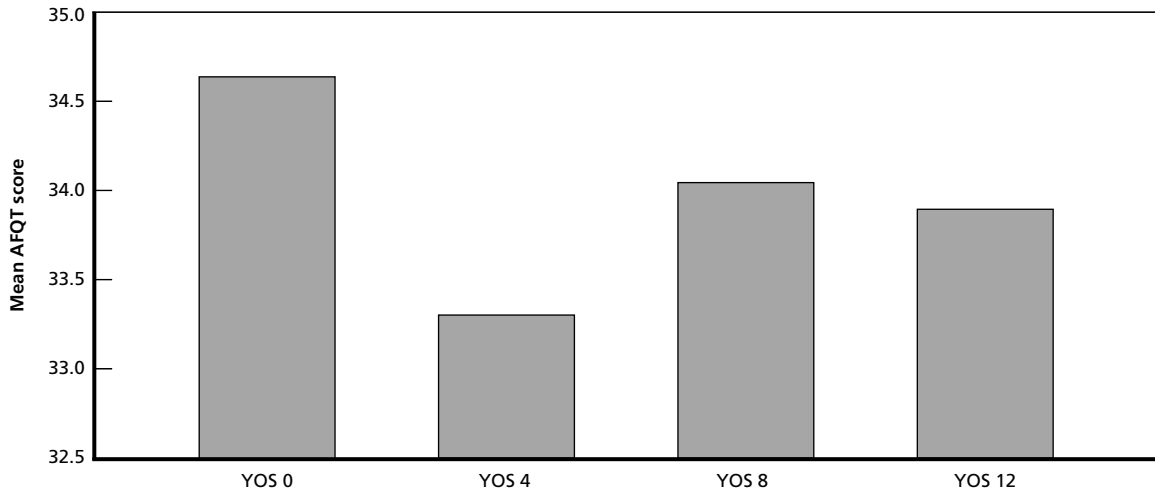
This chapter first examines the retention of high-quality personnel by service, cohort, and occupational area. We then undertake a similar analysis of the promotion of high-quality personnel.

## **Retention of High-Quality Personnel in the Early and Midcareer**

To analyze whether high-quality personnel are disproportionately induced to stay until their early and midcareer, we examine by cohort, service, and occupational area the difference between the mean quality of those who were in service at YOS 4, YOS 8, and YOS 12 and those who were in service at YOS 0, i.e., the entry cohort as a whole. We continue to use our three measures of quality.

Figures 4.1a and 4.1b illustrate the general approach for the FY78 cohort. Figure 4.1a shows the mean quality (in this case, AFQT score) of personnel at YOS 0, YOS 4, YOS 8, and YOS 12 in the Army in occupational area 0 (infantry) for the FY78 cohort. Figure 4.1b shows the difference in mean AFQT score for YOS 4 and YOS 0, the difference in means for YOS 8 and YOS 0, and the difference for YOS 12 and YOS 0. For example, at YOS 4, the mean AFQT score was 33.3, while at YOS 0, it was 34.6, for a difference of -1.3, shown on the right side of Figure 4.1b. The charts that follow will look like Figure 4.1b.

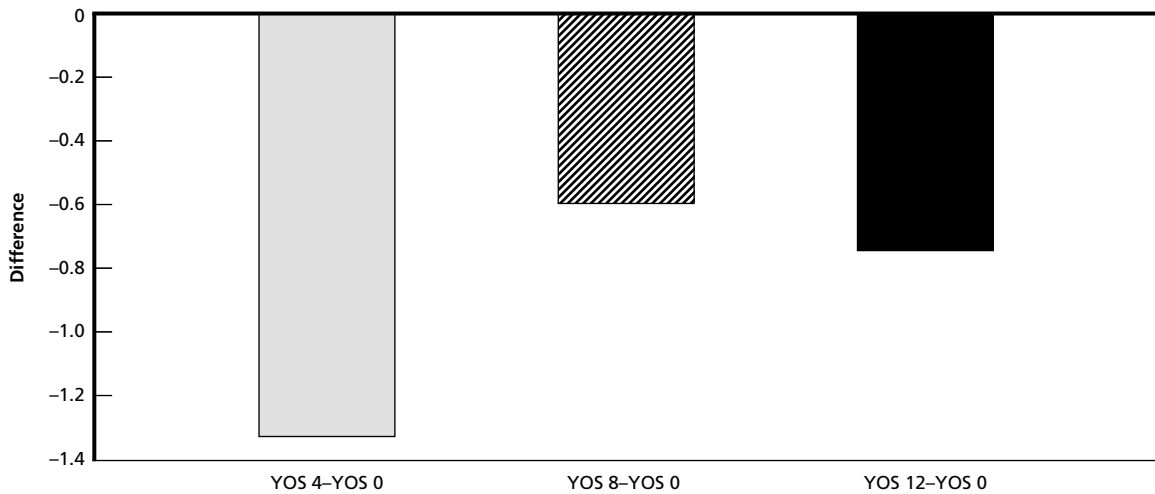
**Figure 4.1a**  
**Mean AFQT Scores at YOS 0, YOS 4, YOS 8, and YOS 12, Army FY78 Cohort, Occupational Area 0**



SOURCE: Authors' calculations using the DMDC DSCAC file.

RAND MG324-4.1a

**Figure 4.1b**  
**Differences Between Mean AFQT Scores at YOS 0, YOS 4, YOS 8, and YOS 12, Army FY78 Cohort, Occupational Area 0**



SOURCE: Authors' calculations using the DMDC DSCAC file.

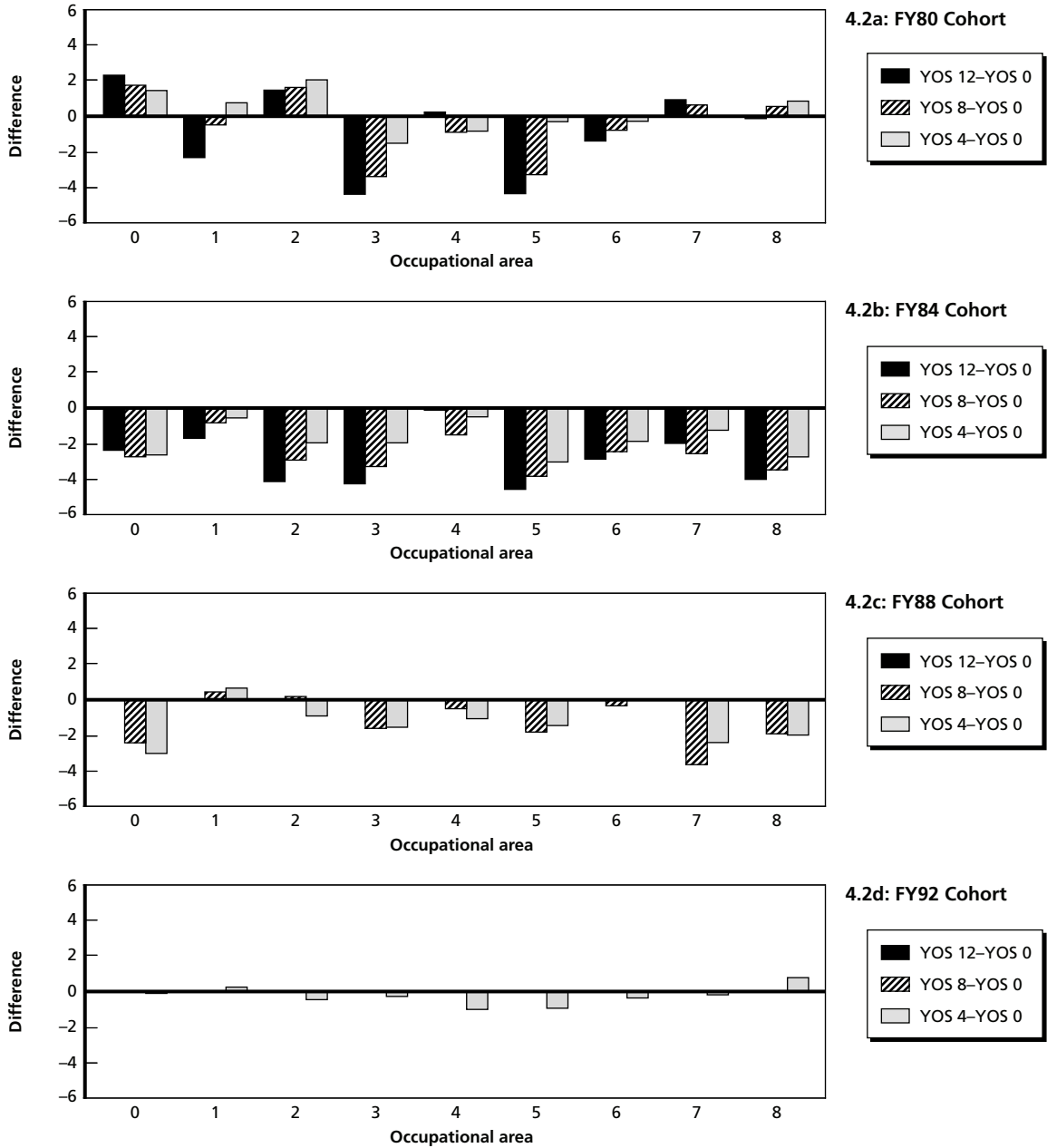
RAND MG324-4.1b

Figures 4.2 through 4.5 show the differences in mean quality for these YOS for the Army, Navy, Marine Corps, and Air Force, respectively, when quality is defined in terms of AFQT scores. For the Army and Navy, we generally find that the differences are either negative or near zero. That is, the quality of those who are retained until the early and midcareer is the same or somewhat lower than the quality of those who enter when quality is measured in terms of AFQT scores.

The differences for the Army generally range from -2 to +2 points across occupational areas and cohorts, with the difference being at most around four points in absolute

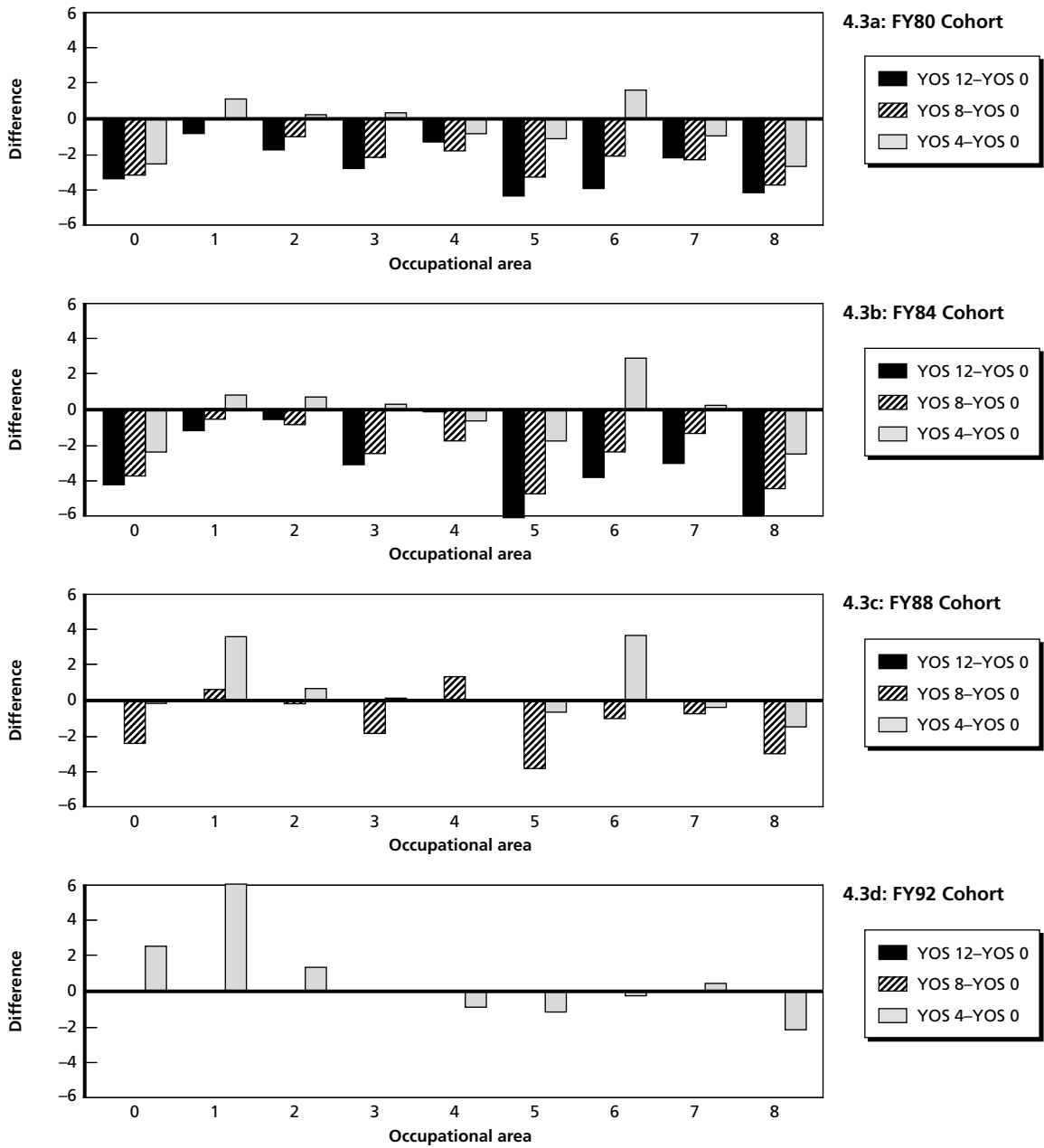
value. In the FY84 cohort we see more consistent negative differences, but, again, the differences are at most four points in magnitude. The differences for the Navy generally range from -4 to 0 points, with a few occupations and cohorts showing a -6 point difference and others showing a positive difference. For example, in the Navy FY84 cohort, those who stay until YOS 12 in occupational area 5 (functional support and administration) have an average AFQT score about six points below the average AFQT of those who entered, while in the FY88 cohort, those who stay until YOS 4 in occupational area 1 have an average AFQT score about four points above those who enter. However, the differences are smaller than two points in absolute value for many occupational areas and cohorts in both the Army and Navy, especially in the FY92 cohort.

**Figure 4.2**  
**Army Mean AFQT Score Differences at YOS 12, YOS 8, and YOS 4, Relative to YOS 0, by Cohort**



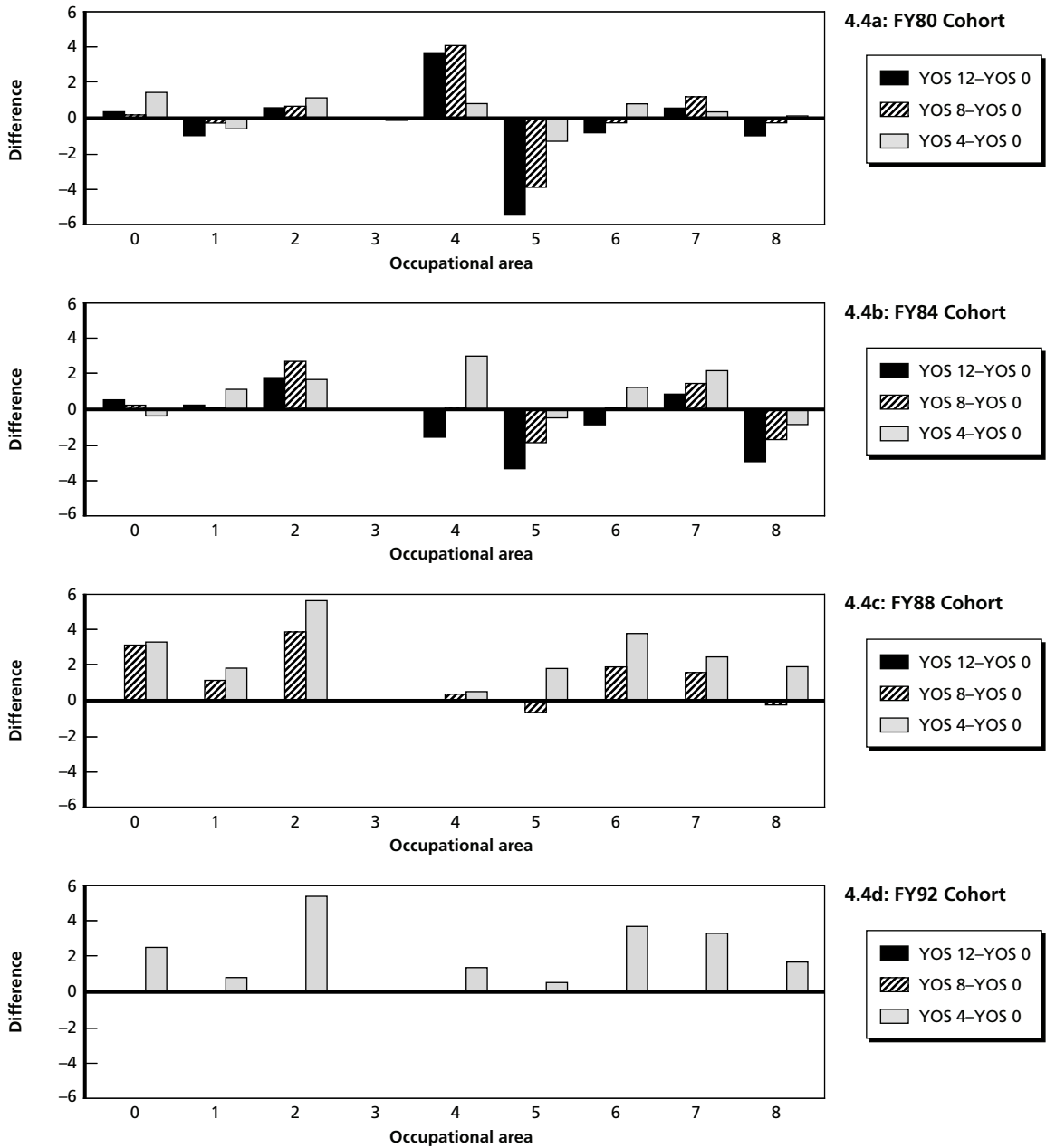
SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas.

**Figure 4.3**  
**Navy Mean AFQT Score Differences at YOS 12, YOS 8, and YOS 4, Relative to YOS 0, by Cohort**



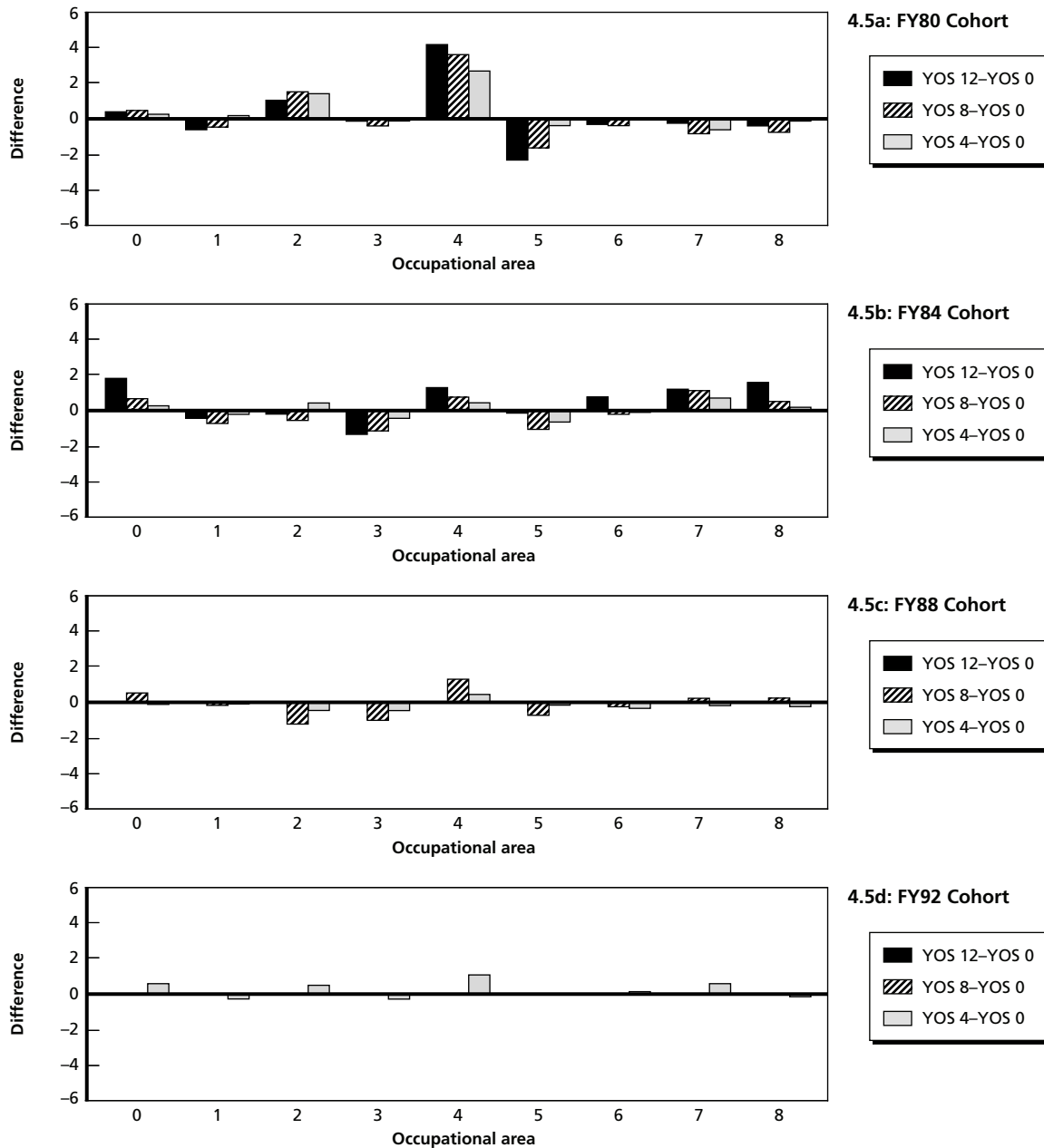
SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas.  
 RAND MG324-4.3

**Figure 4.4**  
**Marine Corps Mean AFQT Score Differences at YOS 12, YOS 8, and YOS 4, Relative to YOS 0, by Cohort**



SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas. The Marine Corps does not have an occupational area 3, medical and dental specialty.  
 RAND MG324-4.4

**Figure 4.5**  
**Air Force Mean AFQT Score Differences at YOS 12, YOS 8, and YOS 4, Relative to YOS 0, by Cohort**



SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas.  
 RAND MG324-4.5

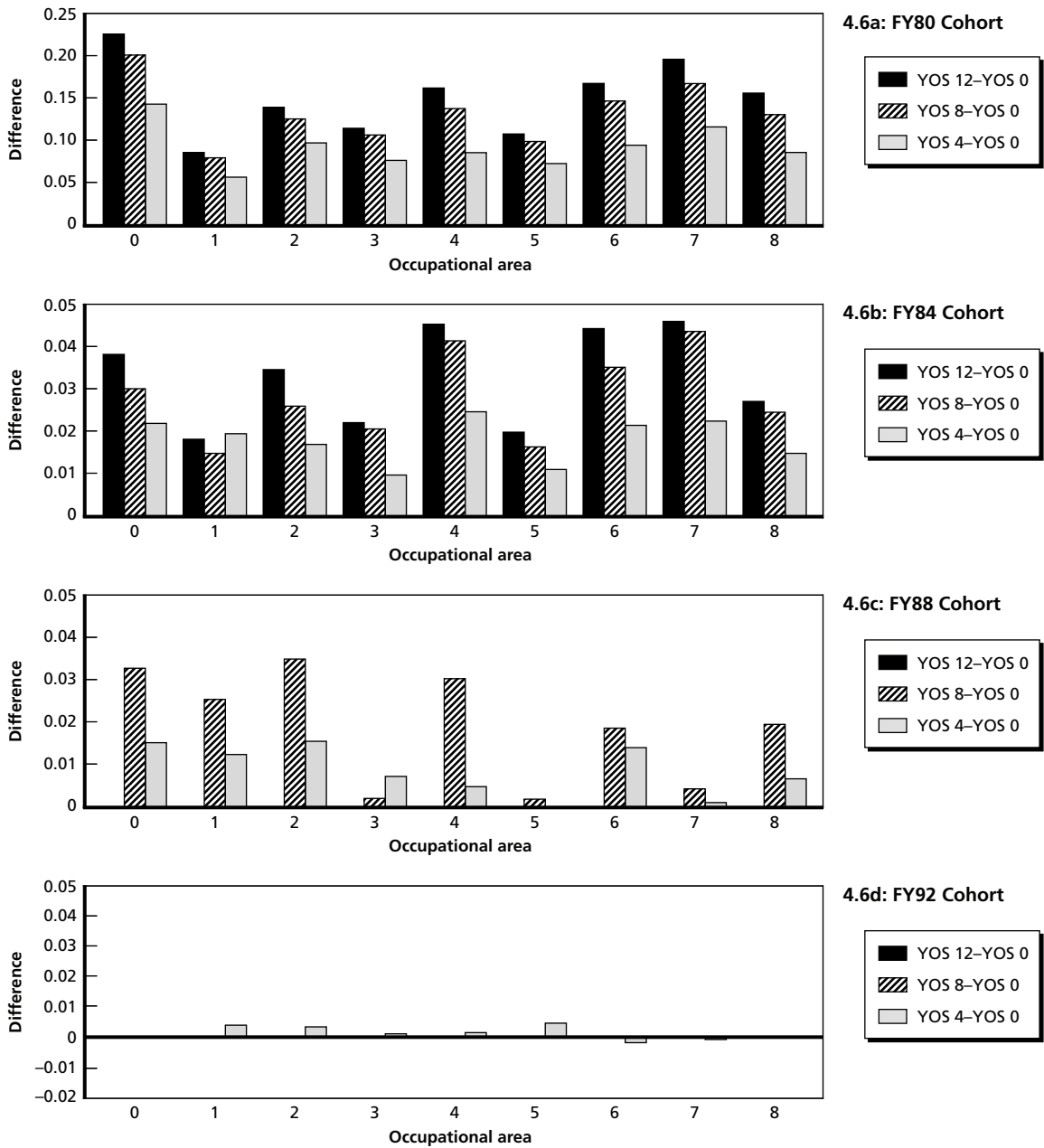
For the Marine Corps and Air Force, the differences in average AFQT scores across YOS are more often positive, especially among the more recent cohorts. For example, the difference is positive for almost every occupational area in the FY88 cohort in the Marine Corps. Thus, those who stay until the early and midcareer are higher quality than those who leave, when quality is measured in terms of AFQT. More generally, in most occupational areas and cohorts for the Marine Corps the differences in average AFQT scores across YOS

range from -2 to +2 points. Some occupational areas show a difference of +4 (or -4) points, and one shows a difference of +6 points. The magnitude of these differences is generally smaller for the Air Force.

To get a feel for the magnitude of differences in mean AFQT score across YOS, recall that the standard deviation of AFQT scores is about 20 to 25 points for those cohorts entering in the earlier years (FY84 and before) and about 15 to 20 points for those cohorts entering later (post-FY84). Therefore, a difference of four points represents 0.16 to 0.26 standard deviations in AFQT scores over the data period. A difference of six points represents 0.24 to 0.40 standard deviations, while a difference of two points represents 0.08 to 0.13 standard deviations. The significance of these differences depends on the value of quality within a service, occupational area, and entry cohort.

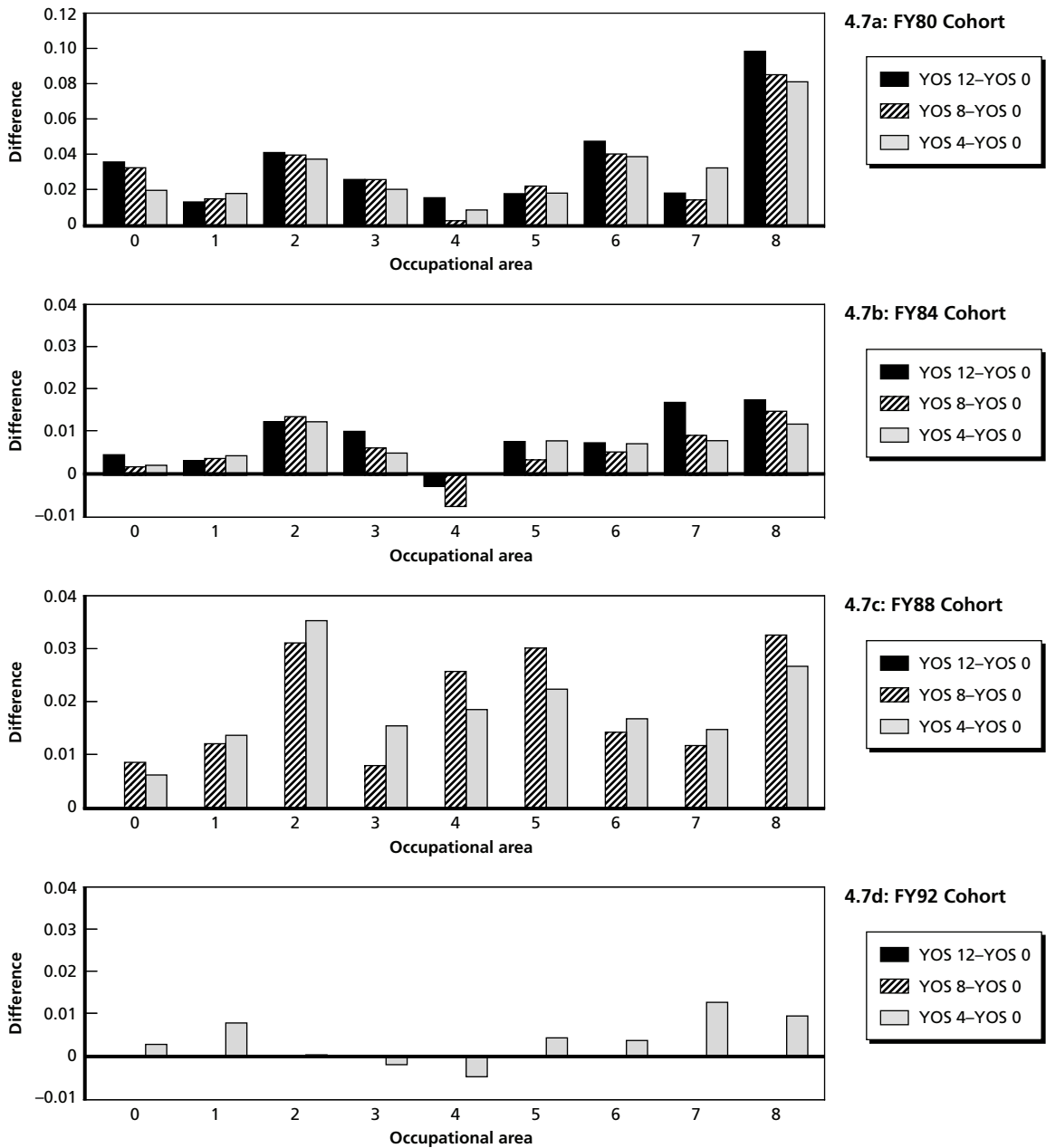
These results are generally consistent with Asch and Warner's (1994b) finding that the average AFQT score of those who stayed was about the same as those who entered. However, that study only presented results for three occupational groups in the Army. Figures 4.2a through 4.5d suggest that this result generalizes to some extent to other services and occupational areas. The fact that the average AFQT score of those who stay is not much different than the average of those who enter in the Army and Air Force and, in many cases, the Marine Corps and Navy, suggests that while the military's compensation and personnel system does not create adverse selection, i.e., selectively induce lower quality personnel to stay, it does not create strong positive selection either when quality is measured by AFQT score.

**Figure 4.6**  
**Army Differences in Fraction with High School Diploma or More Education at Entry at YOS 12, YOS 8, and YOS 4 Relative to YOS 0, by Cohort**



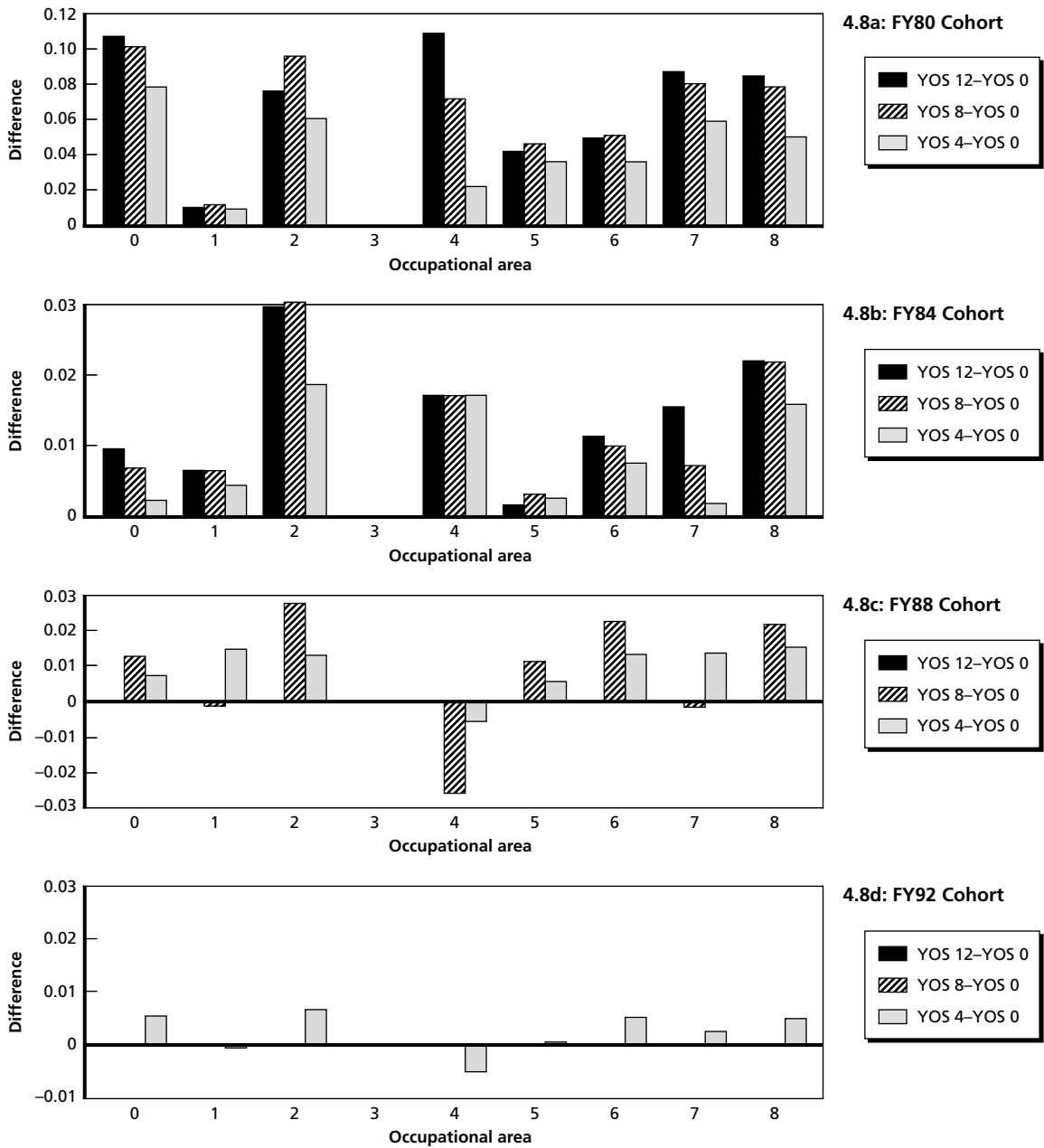
SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas.  
 RAND MG324-4.6

**Figure 4.7**  
**Navy Differences in Fraction with High School Diploma or More Education at Entry at YOS 12, YOS 8, and YOS 4 Relative to YOS 0, by Cohort**



SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas.  
 RAND MG324-4.7

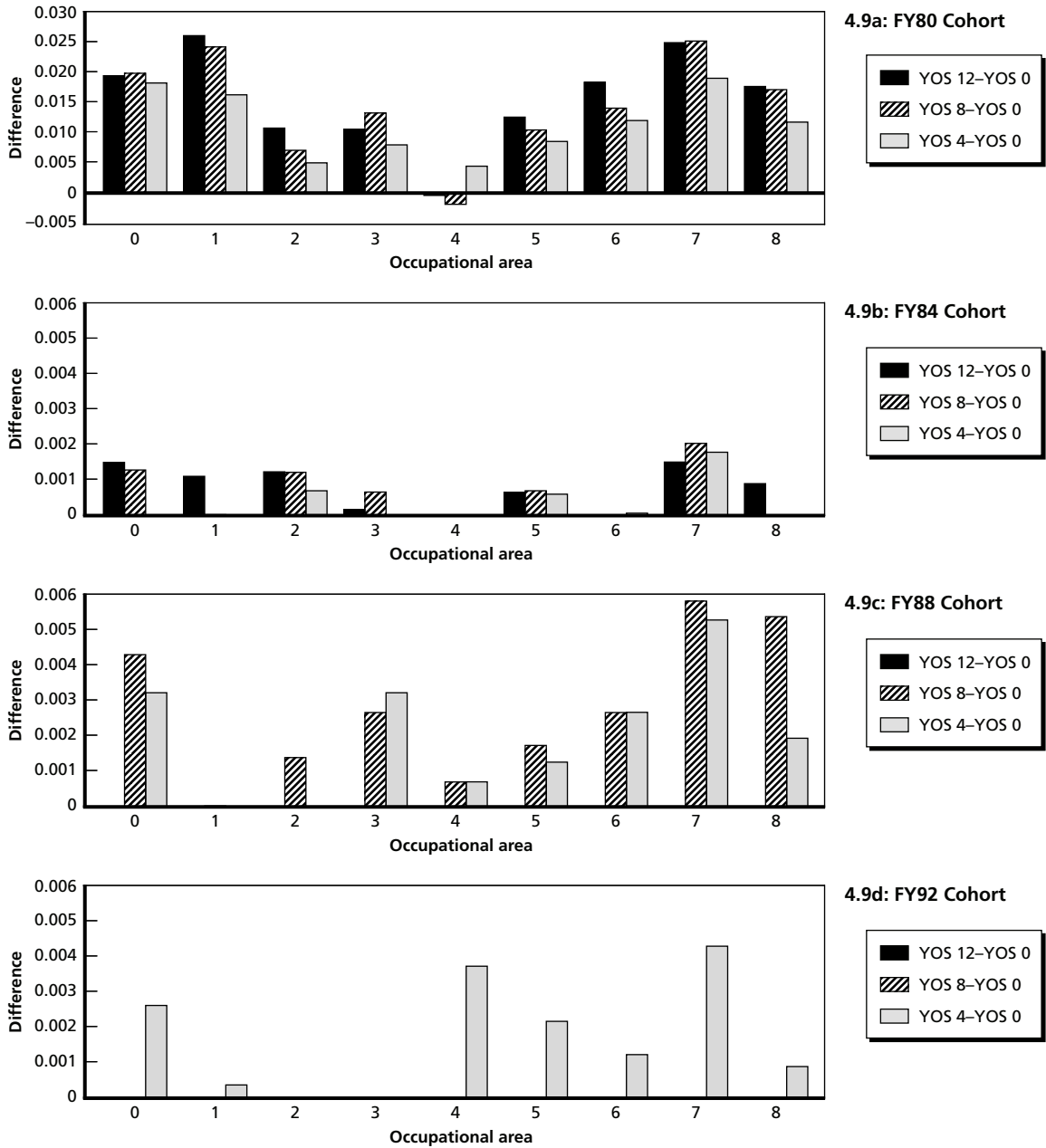
**Figure 4.8**  
**Marine Corps Differences in Fraction with High School Diploma or More Education at Entry at YOS 12, YOS 8, and YOS 4 Relative to YOS 0, by Cohort**



SOURCE: Authors' calculations using the DMDC DSCAC file.

NOTE: See Table 2.1 for definitions of one-digit occupational areas. The Marine Corps does not have an occupational area 3, medical and dental specialty.

**Figure 4.9**  
**Air Force Differences in Fraction with High School Diploma or More Education at Entry at YOS 12, YOS 8, and YOS 4 Relative to YOS 0, by Cohort**



SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas.

We next turn to the question of whether we continue to reach this conclusion even when we use other measures of quality. Figures 4.6 through 4.9 show the differences in mean quality for those who stay relative to the entry point when quality is measured in terms of the fraction of individuals who have a high school diploma or more of education at entry.<sup>2</sup> The Army shows enormous changes in quality for the FY80 cohort, and these changes increase with YOS. For example, in infantry (occupation 0), the difference at YOS 4 in the fraction with a high school diploma or more education at entry relative to YOS 0 was 14 percentage points. At YOS 8, the difference was 20 percentage points, and at YOS 12, it was 22 percentage points.<sup>3</sup> The Army FY80 cohort was low quality with respect to AFQT scores and education (Tables 3.1 and 3.2). The dramatic increase in the percent with a high school diploma with YOS reflects the Army's effort to upgrade the quality of this cohort over time while it sought to increase the quality of future entry cohorts. The results in Figures 4.6a through 4.6d suggest that the Army avoided, or at least mitigated, the problem of employing a cohort of senior noncommissioned officers (NCOs) who were, on average, substantially less educated than the new junior personnel they were responsible for leading.

We see a similar pattern for the Marine Corps among the FY80 cohort, although the differences are not as large as they are for the Army. These results suggest that for the FY80 cohort, high-quality personnel were clearly induced to stay relative to lower-quality personnel when quality is measured in terms of high school education.

For later cohorts in the Army and Marine Corps, and for all the cohorts shown for the Air Force and Navy, the differences in quality for those who stay and those who enter are generally positive but not as large. For example, in the FY84 Army cohort—just four years later—the difference for the infantry occupational area is only two percentage points at YOS 4, only three percentage points at YOS 8, and four percentage points at YOS 12. The lack of any sizable difference after the FY80 cohort could be due to the fact that the fraction of new recruits with a high school diploma or more rose substantially during the 1980s (see Table 2.2). Since nearly everyone who entered had a high school diploma, a significant increase in the fraction with a high school diploma at other career points such as YOS 4, YOS 8 or YOS 12 was not possible. Nonetheless, decreases in the fraction could occur. Consequently, this measure of quality can indicate whether high school graduates are being selectively induced to leave. Figures 4.6 through 4.9 suggest that this has not happened.

Our final measure of quality is the quality index. Table 4.1a reports differences in mean quality, relative to YOS 0, over the course of the early and midcareer for our three-digit DoD occupations. With the usual exception of supply administrators in the Marine Corps's FY92 cohort, those personnel in each group who are retained through the midcareer are of relatively high quality. Table 4.1b reports the differences in the mean quality index

<sup>2</sup> A related quality measure is the fraction of those with high school or more of education at YOS 4, YOS 8, and YOS 12 relative to the fraction at entry. This alternative measure would capture changes in educational attainment that occurred while the individual was in service. Since our focus is on the retention and promotion of high-quality personnel rather than on the incentives to invest in human capital while in service, we use the measure discussed in the text rather than this alternative measure. The accumulation of college education while individuals are in service is discussed in Asch, Kilburn, and Klerman (1999).

<sup>3</sup> Because educational differences were so much more pronounced in FY80, the scale of the vertical axis in the FY80 panel is larger in Figures 4.6–4.9.

attributable to AFQT scores. As before, the differences in quality attributable to AFQT scores are generally negative, indicating that the changes in the revealed quality factors must dominate the lower AFQT scores of personnel retained through the midcareer. Moreover, while the significance of these differences in the quality index for policymakers requires an assessment of the value of personnel quality, their magnitude is much greater than AFQT scores alone would suggest.

Intragroup comparisons are quite interesting. The degree to which the average quality of personnel exceeds that of the entry cohort generally rises with YOS. The rate of increase may be quite meaningful. For instance, the difference in quality between YOS 12 and YOS 0 is almost twice as large as the difference between YOS 4 and YOS 0 for general aircraft repairers who joined the Air Force in FY84. Differences due to AFQT scores alone are relatively stable. Thus, personnel with increasingly better unobserved quality are retained.

If the Ward-Tan model of quality and promotion is valid, the traditional measure of quality based on AFQT score at entry is misleading about the relationship between actual quality and retention through the midcareer, at least for these groups. The military manages to retain personnel of substantially higher quality, and this selection grows with experience and service.

**Table 4.1a**  
Differences in Mean Overall Quality Index ( $q=\beta\text{AFQT}+\varepsilon$ ) at YOS 12, YOS 8, and YOS 4, Relative to YOS 0, by Service, Three-Digit Occupation, and Entry Cohort

Entry Cohort	Service and DoD Occupational Specialty		
	Army 043		
	YOS 4–YOS 0	YOS 8–YOS 0	YOS 12–YOS 0
80	+0.34	+0.41	+0.45
84	+0.20	+0.28	+0.33
88	+0.22	+0.37	—
92	n/a	n/a	n/a
	Marine Corps 551		
	YOS 4–YOS 0	YOS 8–YOS 0	YOS 12–YOS 0
80	n/a	n/a	n/a
84	+0.19	+0.30	+0.30
88	+0.25	+0.33	—
92	-0.38	—	—
	Air Force 600		
	YOS 4–YOS 0	YOS 8–YOS 0	YOS 12–YOS 0
80	+0.09	+0.11	+0.12
84	+0.06	+0.08	+0.11
88	+0.03	+0.04	—
92	n/a	n/a	n/a

SOURCE: Authors' calculations using the DMDC DSCAC file.

NOTES: n/a indicates that the quality index is not available because estimation of the quality model did not yield reliable results for this service/DoD occupation/entry-cohort group. A dash indicates that the index is not available because the data terminate in 1996.

**Table 4.1b**  
**Differences in the Mean Overall Quality Index Due to the Contribution of AFQT ( $\beta$ AFQT) at YOS 12, YOS 8, and YOS 4, Relative to YOS 0, by Service, Three-Digit Occupation, and Entry Cohort**

Entry Cohort	Service and DoD Occupational Specialty		
	Army 043		
	YOS 4–YOS 0	YOS 8–YOS 0	YOS 12–YOS 0
80	+0.00	0.00	0.00
84	-0.02	-0.03	-0.01
88	-0.03	-0.02	—
92	n/a	n/a	n/a
	Marine Corps 551		
	YOS 4–YOS 0	YOS 8–YOS 0	YOS 12–YOS 0
80	n/a	n/a	n/a
84	-0.04	-0.04	-0.05
88	-0.02	-0.04	—
92	-0.39	—	—
	Air Force 600		
	YOS 4–YOS 0	YOS 8–YOS 0	YOS 12–YOS 0
80	-0.01	-0.01	0.00
84	0.00	0.00	0.01
88	-0.01	0.00	—
92	n/a	n/a	n/a

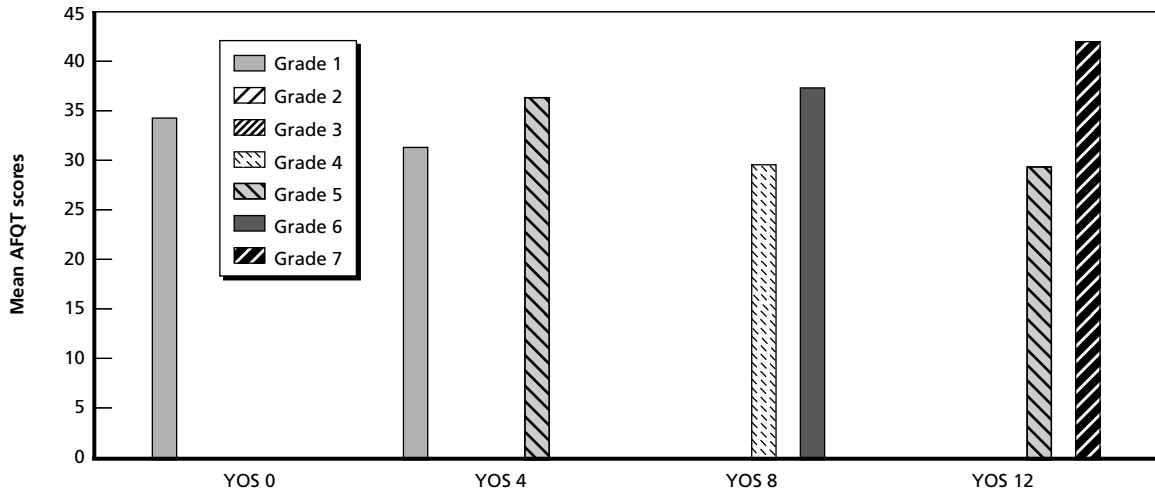
SOURCE: Authors' calculations using the DMDC DSCAC file.

NOTE: n/a indicates that the quality index is not available because estimation of the quality model did not yield reliable results for this service/DoD occupation/entry-cohort group. A dash indicates that the index is not available because the data terminate in 1996.

### Promotion of High-Quality Personnel in the Early and Midcareer

To analyze whether the military identifies and promotes high-quality personnel, we compare the average quality of those in the upper and lower grades within the same YOS. Figures 4.10a and 4.10b illustrate our approach. Figure 4.10a shows the average quality (in this case, AFQT score) at YOS 4 of those personnel in grade five and those still in grade one. In the example shown in Figures 4.10a and 4.10b, the average for those in grade five was 36, and the average for those in grade one was 31, for a difference of five percentage points. This difference is shown in Figure 4.10b. To compute the difference, we subtract the average quality of those in the lower grade from the average quality of those in the upper grade. Similarly, among those who stay until YOS 8, we compare the average AFQT scores at YOS 8 of those personnel in grade six with the average of those in grade four. In Figures 4.10a and 4.10b, the average at grade six was 38 and the average at grade four was 30, for a difference of eight shown on the right side. Among those who stay until YOS 12, we compare the average AFQT scores at YOS 12 of those in grade seven and those in grade five. Note that the grades used to compute the differences in average quality are shown in parentheses in Figure 4.10b. As before, we use our three measures of quality in the comparisons. Also as before, we compare average quality for different services, cohorts, and occupational areas.

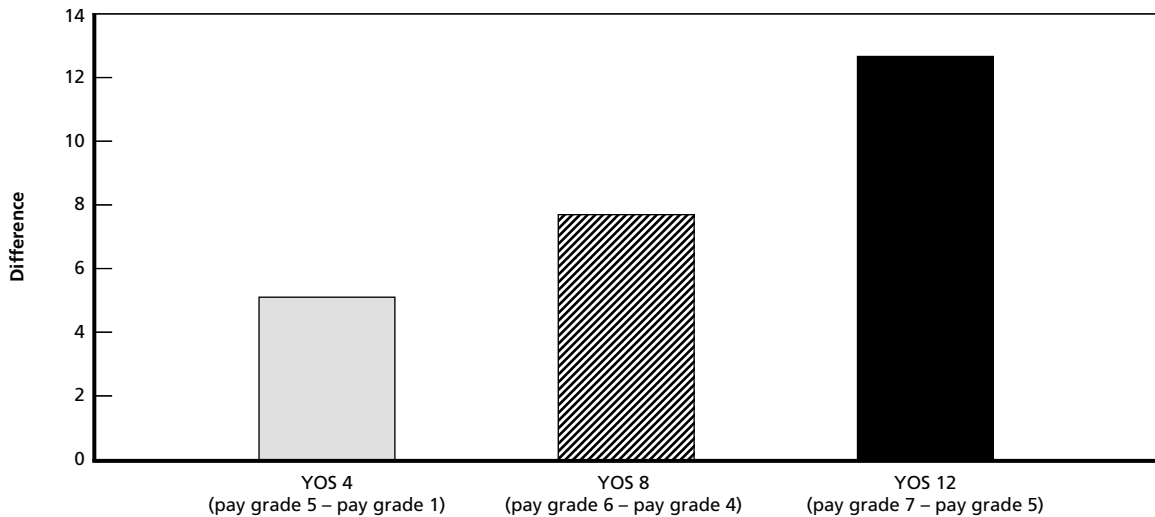
**Figure 4.10a**  
**Mean AFQT Scores by Grade, Army FY78 Cohort, Occupational Area 0**



SOURCE: Authors' calculations using the DMDC DSCAC file.

RAND MG324-4.10a

**Figure 4.10b**  
**Difference in Mean AFQT Scores by Grade, Army FY78 Cohort, Occupational Area 0**



SOURCE: Authors' calculations using the DMDC DSCAC file.

RAND MG324-4.10b

The average quality of personnel who are promoted into the upper grades tends to be much higher than that of personnel in the lower grades, when AFQT is the metric of quality. Figures 4.11a through 4.14d indicate that the differences vary across YOS, service, cohort, and occupational area.<sup>4</sup> Recall from Figures 4.2a through 4.5d that the average AFQT score

<sup>4</sup> We realize that the difference in AFQT scores between grades depends on the YOS that serves as the basis of comparison. For instance, personnel who have reached grade six by YOS 8 have far higher AFQT scores than personnel in grade four at that point. But as more personnel in grade four are eventually promoted to grade five and then grade six, and those in grade

of those retained is generally about the same as the average AFQT score of those who separated. Thus, promotion is generally highly selective in terms of AFQT score, even though retention is not.

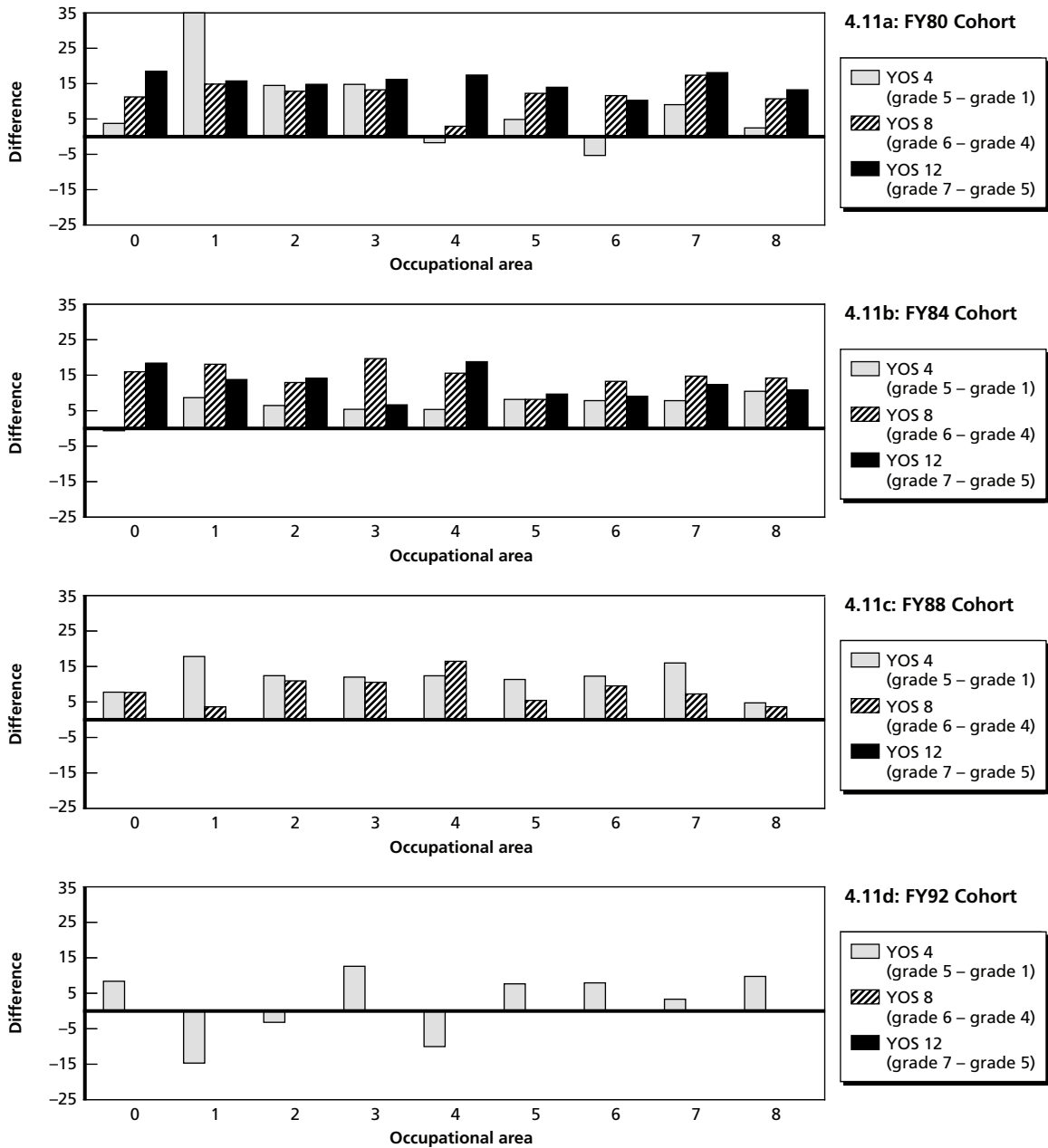
Specifically, the difference in average AFQT scores across grades generally ranges from 10 to 20 points in the FY80 and FY84 cohorts in the Army. For example, for infantry (occupational code 0), the difference in the FY80 cohort is four at YOS 4, 10 at YOS 8, and 19 at YOS 12. That is, of those who reach YOS 12, the average AFQT score of those in grade seven is 19 points higher than the average AFQT score of those in grade five in the FY80 cohort. Given a standard deviation of 22 for this service and cohort, a 19-point difference is 0.86 standard deviations, a relatively large difference. The differences decline somewhat in the later cohorts. For infantry in the FY88 cohort, the difference in average AFQT scores across grades is eight points at YOS 4 and YOS 8, about a 0.35 standard deviation in the AFQT score distribution. Like the range of scores for the Army, the range in the Marine Corps in the average AFQT score across grades is 10 to 20 points, although occupational area 1 shows a negative difference in the FY92 cohort.

In the Navy and Air Force, the differences in average AFQT scores across grades ranges from 15 to 20 points, although some occupations exhibit greater or smaller differences. These differences do not show a clear pattern of increasing or declining with YOS across cohorts or occupations.

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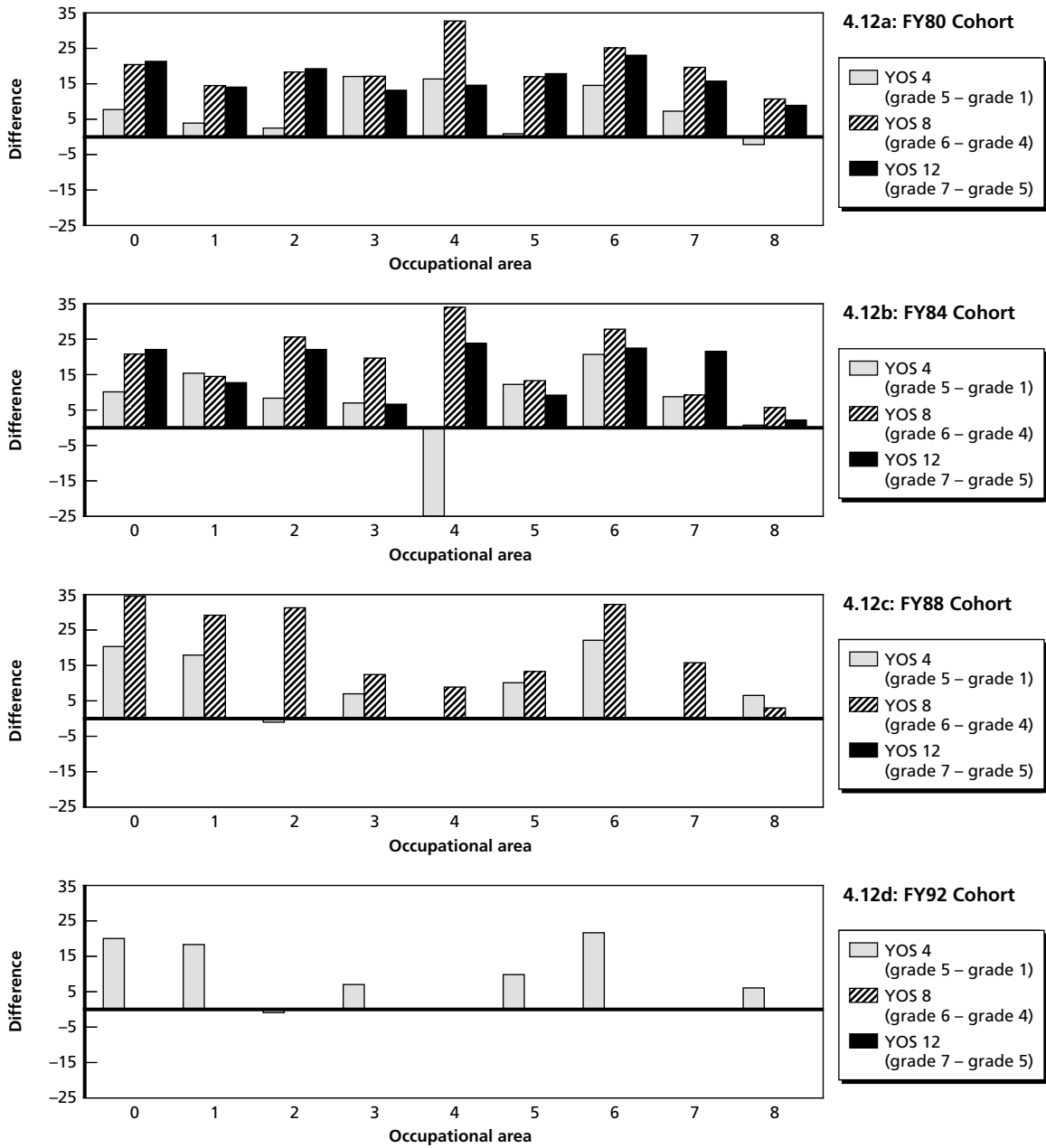
six are promoted to grade seven, the AFQT difference between grades six and four can be expected to narrow with YOS. Our analysis is strongly suggestive, at the least, of the relationship between promotion and quality.

**Figure 4.11**  
**Army Differences in Mean AFQT Scores by Grade at YOS 4, YOS 8, and YOS 12, by Cohort**



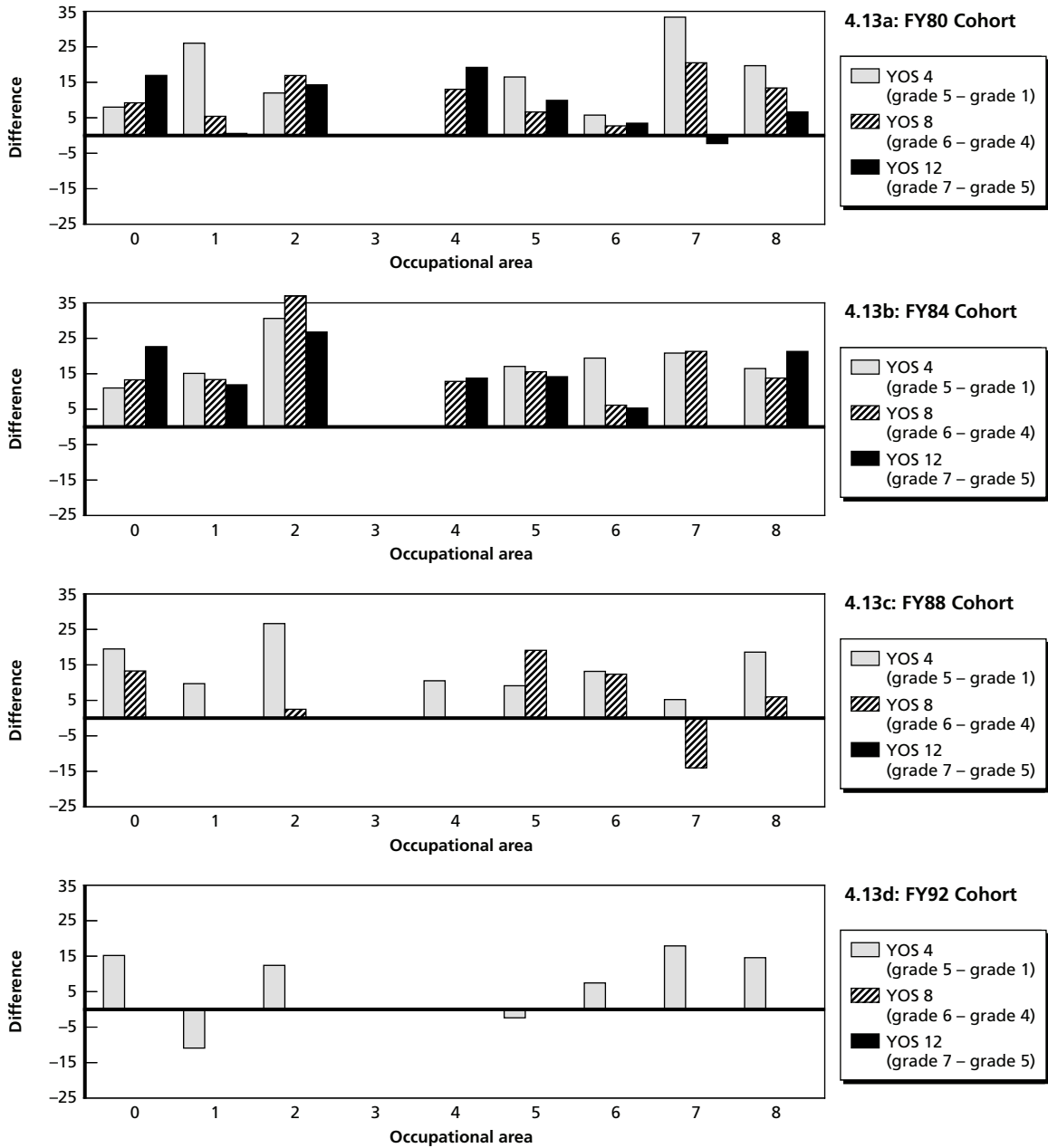
SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas.

**Figure 4.12**  
**Navy Differences in Mean AFQT Scores by Grade at YOS 4, YOS 8, and YOS 12, by Cohort**



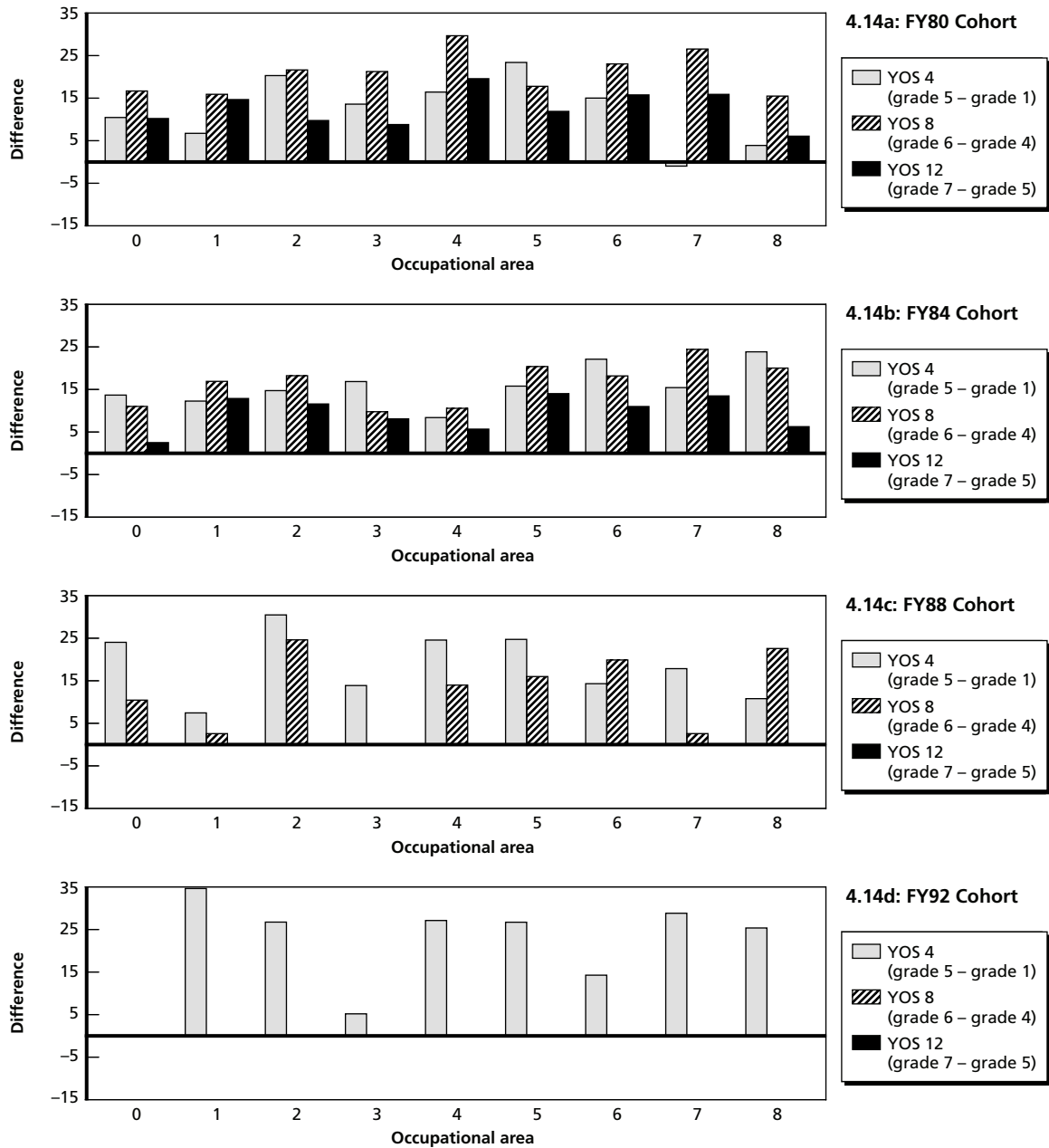
SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas.

**Figure 4.13**  
**Marine Corps Differences in Mean AFQT Scores by Grade at YOS 4, YOS 8, and YOS 12, by Cohort**



SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas. The Marine Corps does not have an occupational area 3, medical and dental specialty.

**Figure 4.14**  
**Air Force Differences in Mean AFQT Scores by Grade at YOS 4, YOS 8, and YOS 12, by Cohort**



SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas.  
 RAND MG324-4.14

Therefore, we conclude from Figure 4.11a through 4.14d that of the personnel who remain in service to a given YOS, those who are promoted into the higher grades have substantially higher AFQT scores on average. Yet, as we discussed earlier, among all personnel, the mean AFQT score of those who leave is generally the same as those who stay. Thus, the military promotes high-quality personnel and retains both high- and low-quality personnel

so that on average, those who stay have the same average AFQT scores as those who leave. Whether this is the optimal policy is debatable.

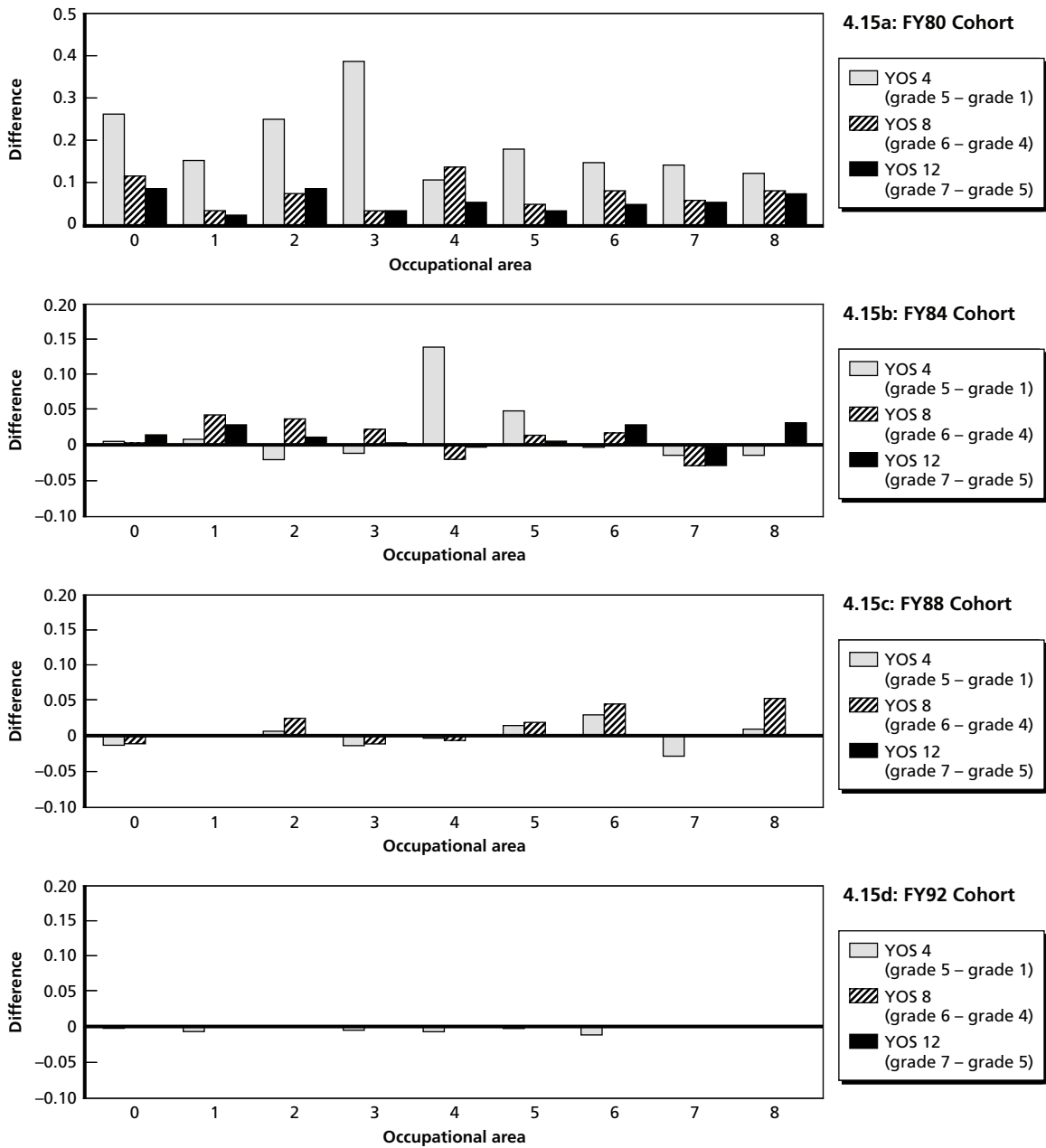
Figures 4.15a through 4.17d show the differences in average quality across grade when quality is defined in terms of percent with a high school diploma or more of education at entry. We find large differences across grades in the fraction with high school or more education for the FY80 cohort when the differences are evaluated at YOS 4.<sup>5</sup> The biggest differences are seen for the Army, although the Navy and Marine Corps FY80 cohorts also exhibit sizable differences. For example, for occupational area 2 (communications and intelligence) in the FY80 cohort evaluated at YOS 4, the grade difference is 25 percentage points for the Army, 14 percentage points in the Navy, and 35 percentage points for the Marine Corps.<sup>6</sup>

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<sup>5</sup> The scale of the vertical axis in the FY80 panel is larger in Figures 4.15a through 4.17d.

<sup>6</sup> Results for the Air Force are not reported because virtually all personnel in this service were high school graduates.

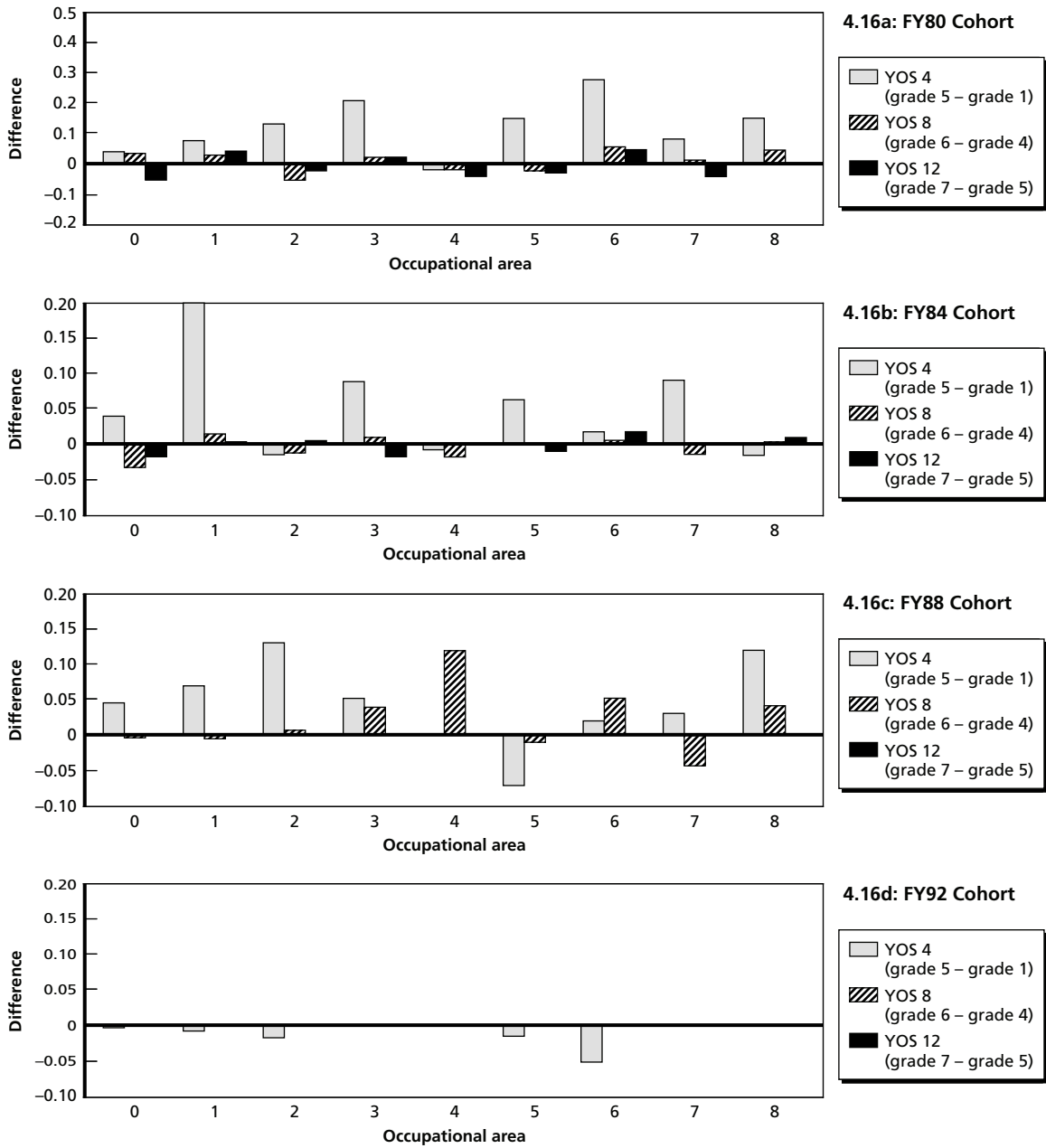
**Figure 4.15**  
**Army Differences in Fraction with High School Diploma or More Education by Grade at YOS 4, YOS 8,**  
**and YOS 12, by Cohort**



SOURCE: Authors' calculations using the DMDC DSCAC file.

RAND MG324-4.15

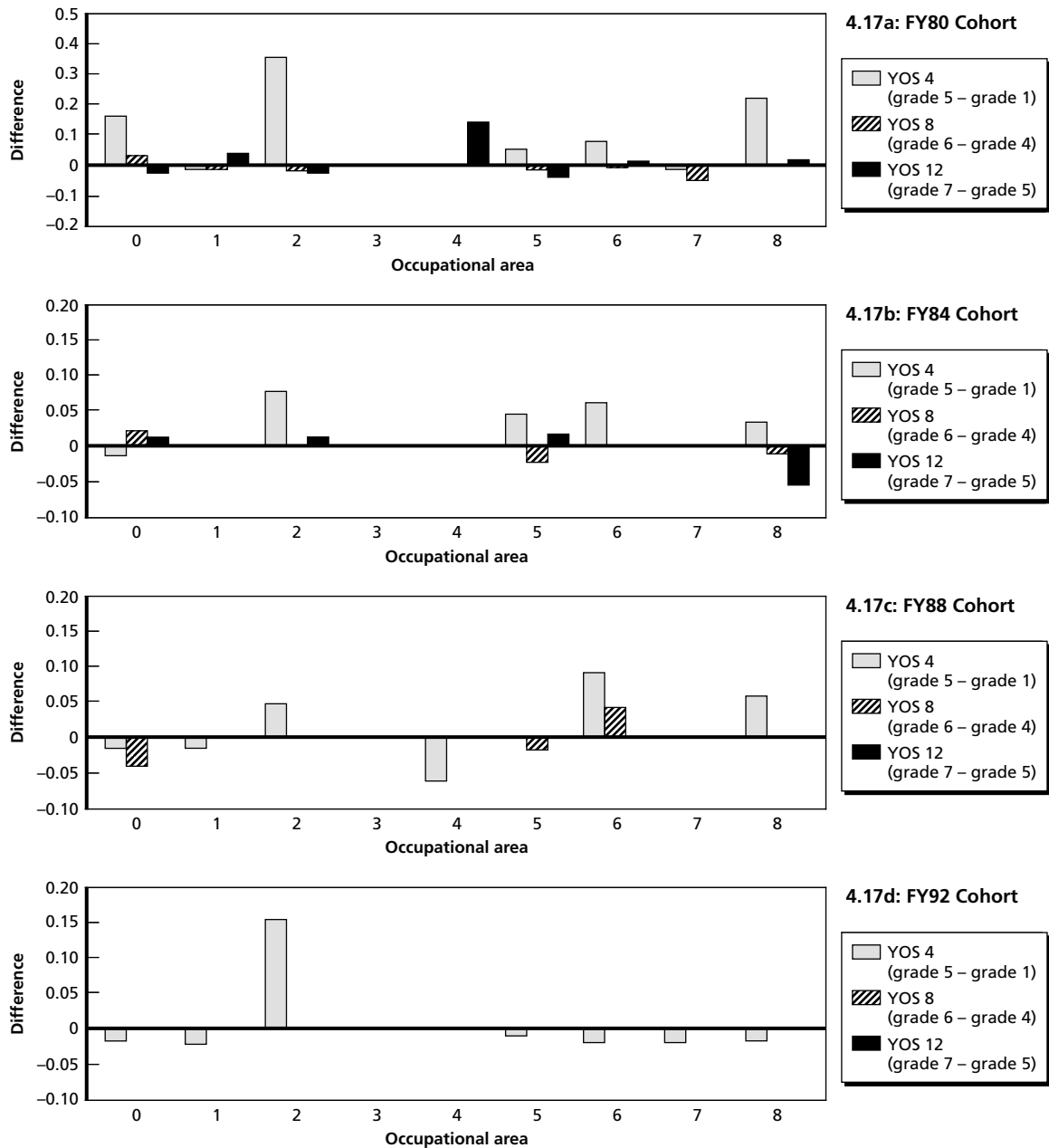
**Figure 4.16**  
**Navy Differences in Fraction with High School Diploma or More Education by Grade at YOS 4, YOS 8,**  
**and YOS 12, by Cohort**



SOURCE: Authors' calculations using the DMDC DSCAC file.

RAND MG324-4.16

**Figure 4.17**  
**Marine Corps Differences in Fraction with High School Diploma or More Education by Grade at YOS 4, YOS 8, and YOS 12, by Cohort**



SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: See Table 2.1 for definitions of one-digit occupational areas. The Marine Corps does not have an occupational area 3, medical and dental specialty.  
 RAND MG324-4.17

The differences evaluated at YOS 8 and YOS 12 are relatively small, even for the FY80 cohort. For example, for occupational area 2 for the Army in the FY80 cohort, the grade difference evaluated at YOS 8 is seven percentage points. As noted earlier, the services upgraded continuing quality in the FY80 cohort; those who remained in service were more

likely to have a high school diploma than those who left. As the fraction with high school or more education increased with YOS for the FY80 cohort, differences in the fraction across grade became smaller, because nearly everyone was a high school graduate among senior NCO personnel.

Figures 4.15a through 4.17d show that the differences among the later cohorts are also relatively small. These differences are negative for some occupational areas at some YOS points. For example, the difference is negative for every occupation shown in the Navy and all but one occupation in the Marine Corps when the difference is evaluated at YOS 4 in the FY92 cohort. In other words, of those who reach YOS 4, those in the upper grades are less likely to have a high school diploma or more. It is possible that this result is due to demotion of those with a high school diploma rather than the promotion of those without a high school diploma. Whatever the reason, the differences are not very large, generally two or three percentage points.

Finally, we compare differences in the mean quality index across grades, as reported in Tables 4.2a and 4.2b. With the exception of supply administrators in the Marine Corps FY92 cohort, personnel in higher ranks are higher quality than those in lower ranks for the same YOS. For instance, the difference in mean overall quality between E-6 and E-4, as of YOS 8, is +0.60 for DoD occupation 043 in the Army. In contrast with first-term completion and reenlistment and with retention through the midcareer, the sign on the differences in the mean quality index attributable to AFQT scores is now generally positive in Table 4.2b, indicating that personnel with higher AFQT scores are promoted within these groups.<sup>7</sup> AFQT score alone continues to understate the magnitude of the differences in quality.

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<sup>7</sup> Occupation 551 in the Marine Corps is an exception as of YOS 4 but not at longer tenures.

**Table 4.2a**  
**Differences in the Mean Overall Quality ( $q=\beta\text{AFQT}+\epsilon$ ) by Grade at YOS 4, YOS 8, and YOS 12, by Service, Three-Digit Occupation Code, and Entry Cohort**

Entry Cohort	Service and DoD Occupational Code		
	Army 043		
	YOS 4 (5-1)	YOS 8 (6-4)	YOS 12 (7-5)
80	+0.38	+0.36	+0.29
84	+0.41	+0.60	+0.55
88	+0.76	+0.51	—
92	n/a	n/a	n/a
	Marine Corps 551		
	YOS 4 (5-1)	YOS 8 (6-4)	YOS 12 (7-5)
80	n/a	n/a	n/a
84	+2.16	+1.45	+0.81
88	+2.08	+1.09	—
92	-2.37	—	—
	Air Force 600		
	YOS 4 (5-1)	YOS 8 (6-4)	YOS 12 (7-5)
80	+2.54	+1.15	+0.82
84	+2.97	+1.49	+1.03
88	+1.51	+0.93	—
92	n/a	n/a	n/a

SOURCE: Authors' calculations using the DMDC DSCAC file.

NOTES: n/a indicates that the quality index is not available because estimation of the quality model did not yield reliable results for this service/occupation/entry-cohort group. A dash indicates that the index is not available because the data terminate in 1996.

Within these groups, differences across grades for the same YOS tend to be larger than those corresponding to retention into the midcareer. For occupation 043 in the Army's FY84 cohort, for instance, the overall quality difference between E-7 and E-5 is +0.55 at YOS 12, while the difference between personnel who reach YOS 12 and the entry cohort as a whole is +0.33. In the cases of occupation 551 in the Marine Corps and 600 in the Air Force, the differences with respect to promotion are an order of magnitude greater than those with respect to retention. Thus, promotion appears to be more selective of quality than retention is, as we concluded with respect to AFQT scores.

Positive differences across grades persist with YOS, suggesting that AFQT scores and first-term promotion remain informative about quality through the midcareer. Yet differences in the overall quality index tend to decline in magnitude with YOS. Differences in the mean quality index due to AFQT scores in Table 4.2b, however, tend to become more positive in some cases, meaning that promotion is more strongly associated with a high AFQT score as tenure increases. The reasons for these patterns are worthy of exploration. The promotion system may emphasize different aspects of quality over the course of the career.

**Table 4.2b**  
**Differences in the Mean Overall Quality Index Due to the Contribution of AFQT Scores ( $\beta$ AFQT) by Grade at YOS 4, YOS 8, and YOS 12, by Service, Three-Digit Occupation Code, and Entry Cohort**

Entry Cohort	Service and DoD Occupational Code		
	Army 043		
	YOS 4 (5-1)	YOS 8 (6-4)	YOS 12 (7-5)
80	0.00	0.05	0.04
84	0.04	0.19	0.25
88	0.06	0.07	—
92	n/a	n/a	n/a
	Marine Corps 551		
	YOS 4 (5-1)	YOS 8 (6-4)	YOS 12 (7-5)
80	n/a	n/a	n/a
84	-0.21	0.34	0.12
88	-0.23	0.31	—
92	-2.45	—	—
	Air Force 600		
	YOS 4 (5-1)	YOS 8 (6-4)	YOS 12 (7-5)
80	0.29	0.30	0.23
84	0.51	0.54	0.26
88	0.09	0.42	—
92	n/a	n/a	n/a

SOURCE: Authors' calculations using the DMDC DSCAC file.

NOTES: n/a indicates that the quality index is not available because estimation of the quality model did not yield reliable results for this service/occupation/entry-cohort group. A dash indicates that the index is not available because the data terminate in 1996.

Refinements to the quality index might deliver insights into the workings and performance of the military's compensation and personnel systems. A comparison of the index with objective measures of performance could validate its practical value. Second, standardization of the index across services, cohorts, and occupations would permit a comparative assessment of system performance. Next, an analysis of promotion beyond E-5 might reveal whether the weights on AFQT scores and unobservable factors shift over the course of the military career, as, for instance, the importance of leadership increases. Lastly, the reenlistment decision may be informative about quality, insofar as quality influences promotion and promotion affects reenlistment (Buddin et al., 1992).



## Conclusions

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This study examines the military's past success in attracting, retaining, and promoting high-quality personnel through the midcareer using data on enlisted personnel who entered each of the armed services between FY78 and FY92 and tracking them through FY96. The analysis of retention and promotion into the midcareer is a leading contribution to the existing literature.

We use two traditional measures of personnel quality (namely, AFQT score and high school graduate status) that measure quality at entry as well as a "quality index" that is intended to reflect quality as revealed on the job. The quality index uses AFQT scores as well as information on speed of promotion to grades E-4 and E-5 to garner information about job performance. We conducted the analysis by service, entry cohort, and occupational area. The main results are as follows:

- The average AFQT scores of those recruited rose substantially during the early 1980s. Furthermore, we find that the mean AFQT scores of those retained through the midcareer are generally similar to the scores of those who separate. Thus, the quality of the entry cohort is the main determinant of cohort quality in general, when AFQT score is the quality metric. Personnel in higher pay grades had substantially higher mean AFQT scores, holding YOS constant. Together with past research that shows AFQT score to be correlated with hands-on metrics of performance, our research confirms the importance of AFQT scores in screening qualified applicants for enlistment and setting pay to ensure the enlistment of high-aptitude recruits.
- The fraction of recruits who were high school diploma graduates rose substantially over time among cohorts entering from 1978 to 1984. The services were able to retain these high school graduates selectively through the midcareer. Beyond 1984, over 90 percent of all entrants were graduates, so limited variation relevant to our analysis existed in this measure.
- When the quality index is used, we find that the quality of those retained was substantially greater than that of those who separated. That is, by this measure, the services were quite successful in selectively retaining high-quality personnel through the mid-1990s when our data end. The services were also quite successful in promoting high-quality personnel. The mean quality index was substantially higher among those in higher grades. Thus, these results indicate that, holding AFQT scores constant, members who are of higher quality in terms of factors that are revealed on the job and through the promotion process but not available at entry are more likely to be retained and promoted to higher ranks. These quality factors may include

fortitude, suitability for the military, skill and taste for service, ability to cope in hostile or stressful situations, ability to work well in teams, and so forth.

The Ward-Tan approach is clearly useful: the quality index is designed to provide additional information about quality than what is available at entry, based on promotion tempo. Interestingly, our results differ when we use AFQT scores from when we use the quality index to measure personnel quality. Using the quality index as the metric, we find that the services are more likely to retain than to separate high-quality personnel, while the quality of those who leave and those who stay is not much different when AFQT score is used as the metric. While we have no benchmark by which to judge whether sufficient numbers of high-quality personnel have been retained or whether the quality of those retained was high enough, these effects are in the right direction. Both indicate past success of the military's compensation and personnel systems. As noted in the introduction, the need for high-quality personnel will only grow as the armed forces transform their capabilities in light of the new defense strategy. Policymakers will need to monitor recruiting and retention outcomes to ensure that the compensation and personnel systems continue to deliver high-quality personnel to meet future manpower needs.

## Trends in First-Term Attrition, Reenlistment, and Retention

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This appendix presents an overview of the trends in first-term attrition, reenlistment, and retention rates for cohorts that entered since FY78. The definitions of attrition, reenlistment, and retention are provided in Chapter Three.

Figure A.1 shows first-term attrition rates for cohorts that entered from FY78 through FY92 by service and by one-digit occupational area. Figure A.2 shows first-term reenlistment rates by service and occupational area. Figure A.3 shows the disposition of each entry cohort at the end of its first term for two occupational areas, functional support and administration (DoD occupational code 5) and electrical/mechanical equipment repair (DoD occupational code 6).<sup>1</sup>

### Attrition

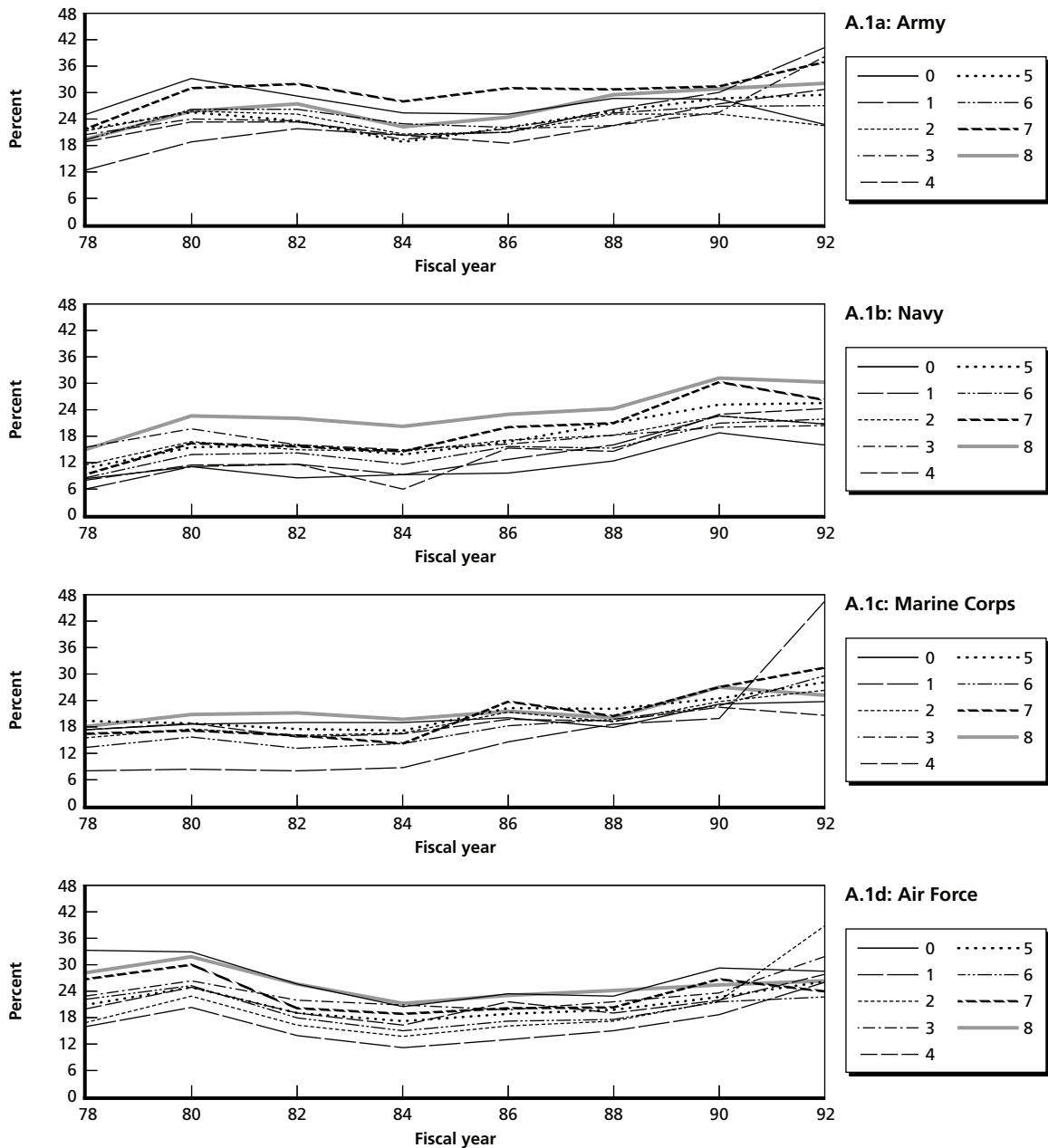
First-term attrition rates have risen significantly for cohorts entering since FY84. The increase was particularly dramatic for the Navy and Marine Corps, although the rise for the Army and Air Force was also significant. For example, in the electrical/mechanical equipment repair occupational area (DoD occupation group 6), the attrition rate rose by 154 percent in the Navy, from nine percent to 22 percent of entering personnel. It also rose by over 100 percent in the Marine Corps, from 13 percent to 29 percent of entering personnel. The increases for the Army and Air Force were 40 percent and three percent, respectively, for this occupational group.

In the case of the Navy, the rise in first-term attrition rates occurred primarily for cohorts entering between FY84 and FY90. In fact, for several occupational groups, first-term attrition rates actually declined for those entering in FY92, relative to the rates for those entering in FY90. For example, in the infantry, gun crew, and seamanship occupational area (DoD occupational group 0), the first-term attrition rate in the Navy fell from 19 percent of entering personnel in FY90 to 16 percent in FY92.

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<sup>1</sup> These two one-digit occupational areas account for one-third of DoD's active force and 30 percent of the Army's active force (DoD, 2004a).

**Figure A.1**  
**Attrition Rates by Entry Cohort and One-Digit DoD Occupation, by Service**



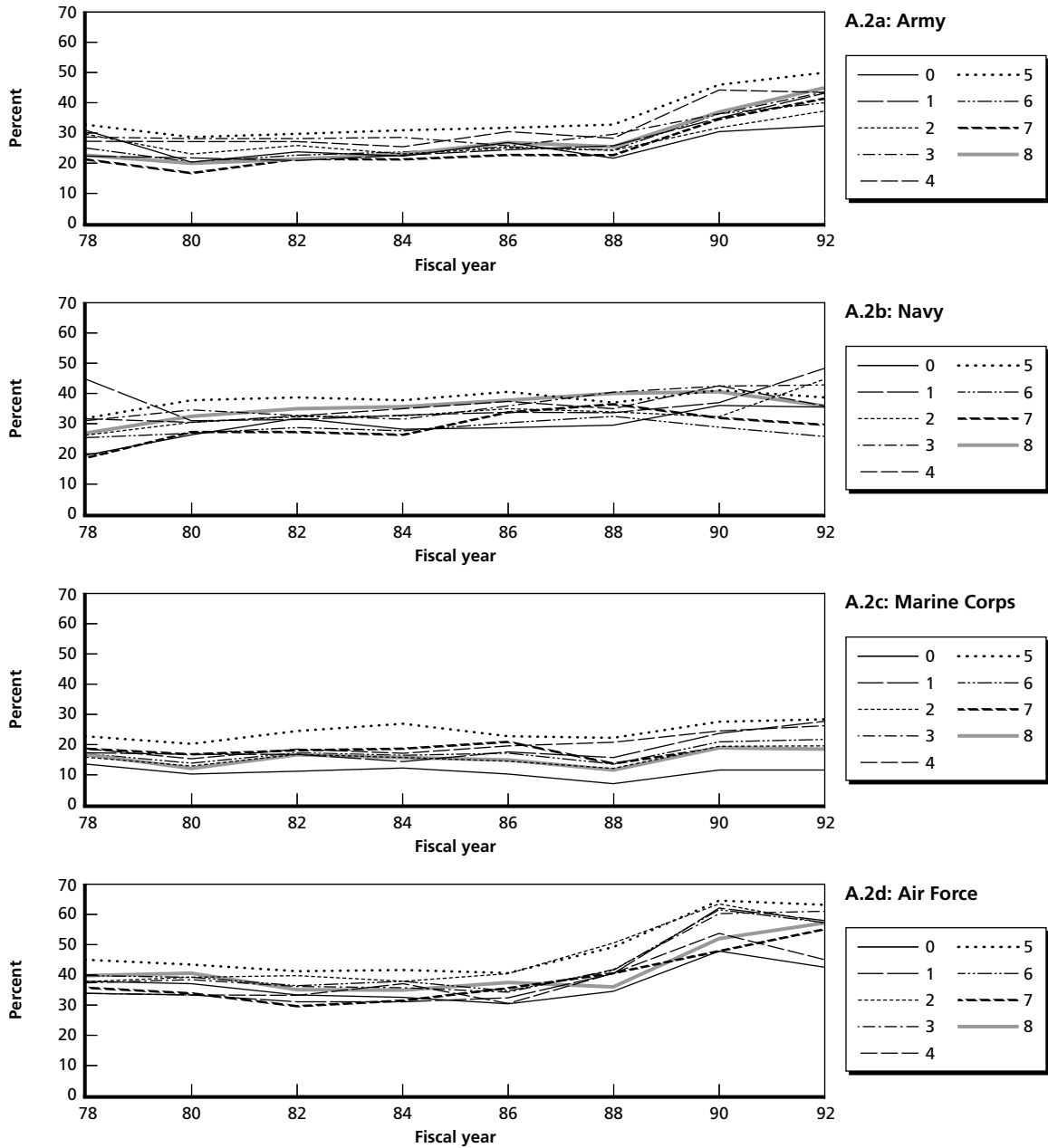
SOURCE: Authors' calculations using the DMDC DSCAC file.  
 RAND MG324-A.1

Because of the large increases in first-term attrition rates for Navy and Marine Corps personnel, these are closer to, but still somewhat below, the rates found in the Army, the service that has traditionally had the highest first-term attrition rate. First-term attrition rates in the Air Force have also approached those found in the Army. Consequently, first-term attrition rates across the services have become more uniform for recent entering cohorts.

While Army and Air Force first-term attrition rates have risen for cohorts entering since FY84, a more notable trend, especially for the Air Force, was the decline in first-term

attrition rates among cohorts entering these services between FY80 and FY84. For example, among electronic equipment repairers (DoD occupational group 1) entering the Air Force, the first-term attrition rate fell from 21 percent among those entering in FY80 to 12 percent among those entering in FY84. Among those entering the Army infantry occupational group (DoD occupational area 0), the first-term attrition rate fell from 33 percent among those entering in FY80 to 25 percent among those entering in FY84.

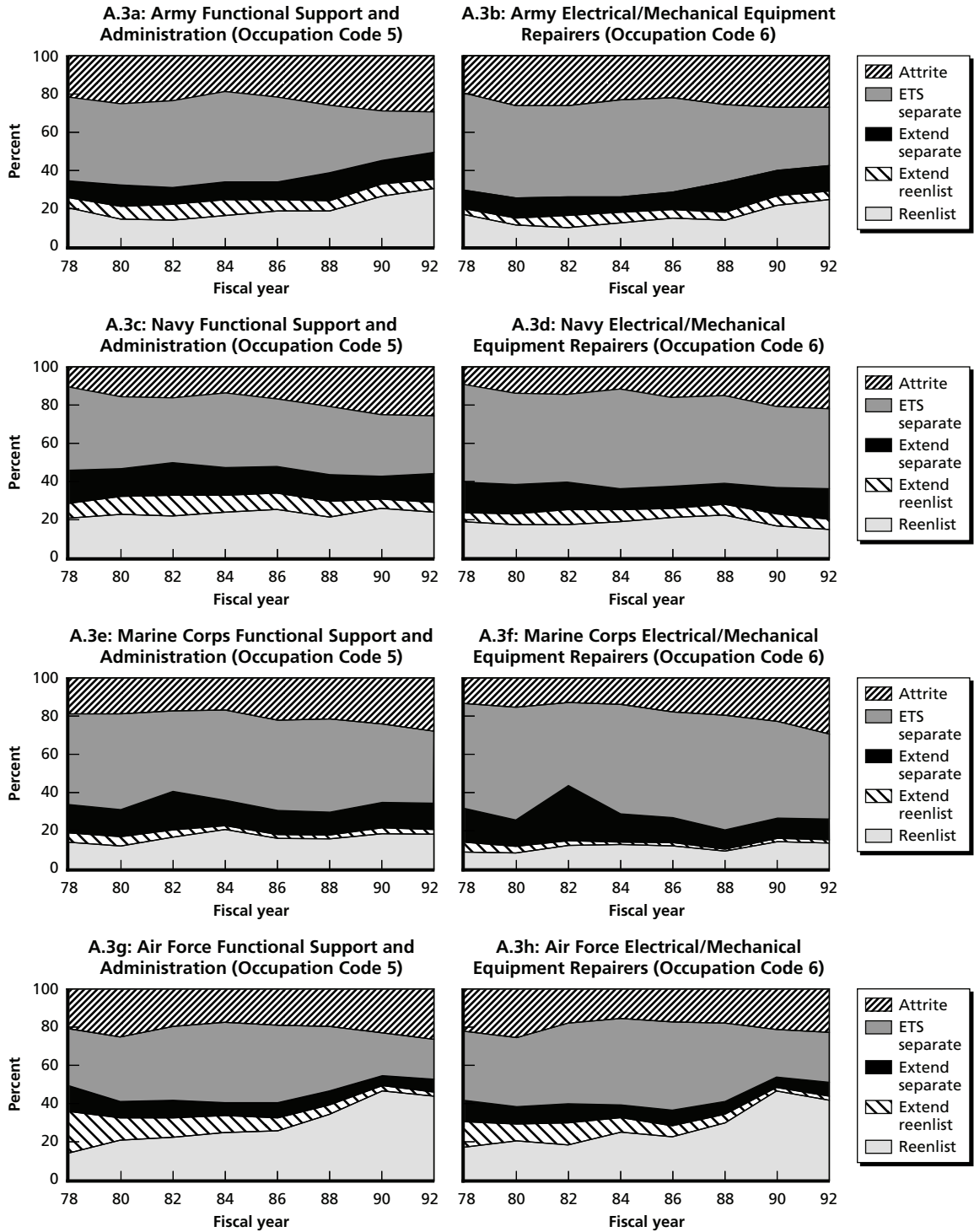
**Figure A.2**  
**Reenlistment Rates by Entry Cohort and One-Digit DoD Occupation, by Service**



SOURCE: Authors' calculations using the DMDC DSCAC file.  
 RAND MG324-A.2

Because of the U-shaped trend in first-term attrition rates for cohorts entering the Army and Air Force since FY80, rates for the FY92 cohort are quite similar to those for FY80 and FY82. This similarity is notable because attrition rates in the early 1980s were considered unacceptably high in the Army. As noted above, first-term attrition rates for the Navy and Marine Corps for the FY92 cohorts were approaching the high rates found in the Army. Therefore, first-term attrition rates are high across all the services among recent cohorts.

**Figure A.3**  
**Disposition of Entry Cohorts at the End of the First Term by Entry Cohort, by One-Digit Occupation Code**



SOURCE: Authors' calculations using the DMDC DSCAC file.

RAND MG324-A.3

The factors that explain these increases in first-term attrition rates since the FY84 cohort are unclear and require further research. Some possible explanations include tougher standards for remaining in service, less physically fit recruits, changes in the attitudes and commitment of recent recruits, poorer personnel management, changes in the nature of service due to the drawdown of the military forces and the greater prominence of peace operations, structural changes in the civilian labor market opportunities of military personnel, and the rise in the proportion of recruits who are female.

## Reenlistment

First-term reenlistment rates rose significantly for those entering the Army and Air Force in recent years. For the Army, the increase began among the FY88 cohort. For the Air Force, the increase occurred among those entering from FY86 to FY90. The reenlistment rates leveled off for cohorts entering the Air Force between FY90 and FY92. For example, in the Army, the reenlistment rate rose from 22 to 32 percent, a 45-percent increase, in the infantry occupational area (occupational group 0) and from 32 to 50 percent, a 56-percent increase, in occupational group 5 (functional support and administration) between the FY88 and FY92 cohorts. Among the FY86 cohort entering the Air Force in occupation group 5, 40 percent of those who completed their first terms reenlisted, while among the FY90 cohort, 64 percent reenlisted, an increase of 56 percent. The reenlistment rate remained about the same among FY92 cohort, at 63 percent.

In contrast to the Army and Air Force, Navy and Marine Corps reenlistment rates have been more stable, with only a slight increase in some occupational areas, for cohorts entering since FY78. Marine Corps reenlistment rates were fairly steady until the FY88 cohort, when they fell somewhat. The rates generally returned to their pre-FY88 cohort level and then rose slightly more. The pattern for the Navy differed across occupational areas. In some areas, reenlistment rates remained quite stable between the FY78 and FY92 cohort. In other areas, the rates rose or fell somewhat over this period. For example, in occupational area 6 (electrical and mechanical equipment repair), the Navy reenlistment rate was 26 percent among the FY78 cohort, rose to 31 percent among the FY86 cohort, and fell back to 26 percent among the FY92 cohort. On the other hand, in occupational area 1 (electronic equipment repair), the reenlistment rate was 45 percent among the FY78 cohort, fell to 31 percent among the FY80 cohort, remained stable for several cohorts, and rose back to 48 percent among the FY92 cohort.

As Figures A.2a through A.2d illustrate, reenlistment rates vary across the services with the Marine Corps generally having the lowest rates and the Air Force generally having the highest rates. Among the FY92 cohort, Marine Corps reenlistment rates generally ranged from 20 to 28 percent across occupational areas. For the Army and Navy, the range among the FY92 cohort was generally about 35 to 45 percent, significantly higher than the Marine Corps rates. The Air Force reenlistment rates generally ranged from 40 to 60 percent across occupational areas for those entering in FY92.

As with the attrition rates, determining the factors that explain these trends and differences across service requires further research.

## Retention

To illustrate the disposition of each entry cohort at the end of the first term for different occupations, Figures A.3a through A.3h show for each service the fraction of each entry cohort in two occupational areas that reenlisted, extended then reenlisted, extended then separated, separated, or failed to complete their terms (i.e., attrited). Figures A.3a, A.3c, A.3e, and A.3g show the rates for functional support and administration (occupational code 5), and Figures A.3b, A.3d, A.3f, and A.3h show them for electric and mechanical equipment repairers (occupational code 6). The figures summarize overall retention during and through the first enlistment term for these occupational areas.

As noted earlier, attrition rose significantly among Navy cohorts, and this trend is also seen for the two occupational areas shown in Figures A.3c and A.3d. The rise in attrition occurred at a time when reenlistment (including those who extend and reenlist) had been generally stable or had risen slightly. We find that most of the rise in attrition came at the expense of a decline in those who separate at the end of their first terms. In other words, retention rates were generally stable. These trends are seen in DoD occupational area 5 in Figures A.3a, A.3c, A.3e, and A.3g. In occupational area 6, the retention rate was fairly steady among those entering between FY78 and FY88, but then it declined somewhat for those entering between FY88 and FY92. Most of this decline occurred because of a rise in the attrition and extension rates. Overall, by FY92, 20 percent of those entering occupational area 6 and 29 percent of those entering occupational area 5 in the Navy remained in service at the end of their first terms.

Attrition has risen and reenlistment (including extension followed by a reenlistment) has been relatively stable, with a slight increase in the Marine Corps for cohorts entering between FY78 and FY92. Like the Navy, the increase in attrition occurred at the expense of a decline in those who separated at the end of their first terms. Consequently, the fraction of the entry cohorts that are retained through the end of the first term was fairly stable in the Marine Corps in the two occupational areas shown. The Marine Corps retained 15 percent of those who entered in FY78 in occupational area 6, and 19 percent of those in occupational area 5. Among the FY92 cohort, the Marine Corps retained 16 percent of those in the electrical and mechanical equipment repair occupational area and 20 percent of those in the functional support and administration occupational area. The generally low retention rates reflect the fact that the vast majority of those in the Marine Corps are first-term personnel.

Although Army and Air Force attrition rose as well, the fraction of the entry cohorts that reenlisted has risen among recent cohorts. Consequently, in contrast to the Navy and Marine Corps, Army and Air Force retention rates have risen in recent years. Among the FY78 entering cohort, the Air Force retained 31 percent of those entering the electrical and mechanical equipment repair area and retained 36 percent of those entering the functional support and administration area. These figures rose to 44 percent and 46 percent among the FY92 cohort, respectively. In the case of the Army, the retention rate was 26 percent and 20 percent among the FY78 cohort entering occupational areas 5 and 6, respectively. These rates rose to 35 percent and 29 percent, respectively, among the FY92 cohort. The high retention rates among Army and Air Force personnel means that a larger share of these personnel are in their second term or are career personnel.



## Early and Midcareer Retention Trends

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Figures B.1 through B.4 show the fraction of each entry cohort that is still in service at YOS 4, YOS 8, and YOS 12 for the Army, Navy, Marine Corps, and Air Force, respectively. That is, the figures show the percent of the initial cohort that reached YOS 4, YOS 8, and YOS 12 in each service and occupational area.

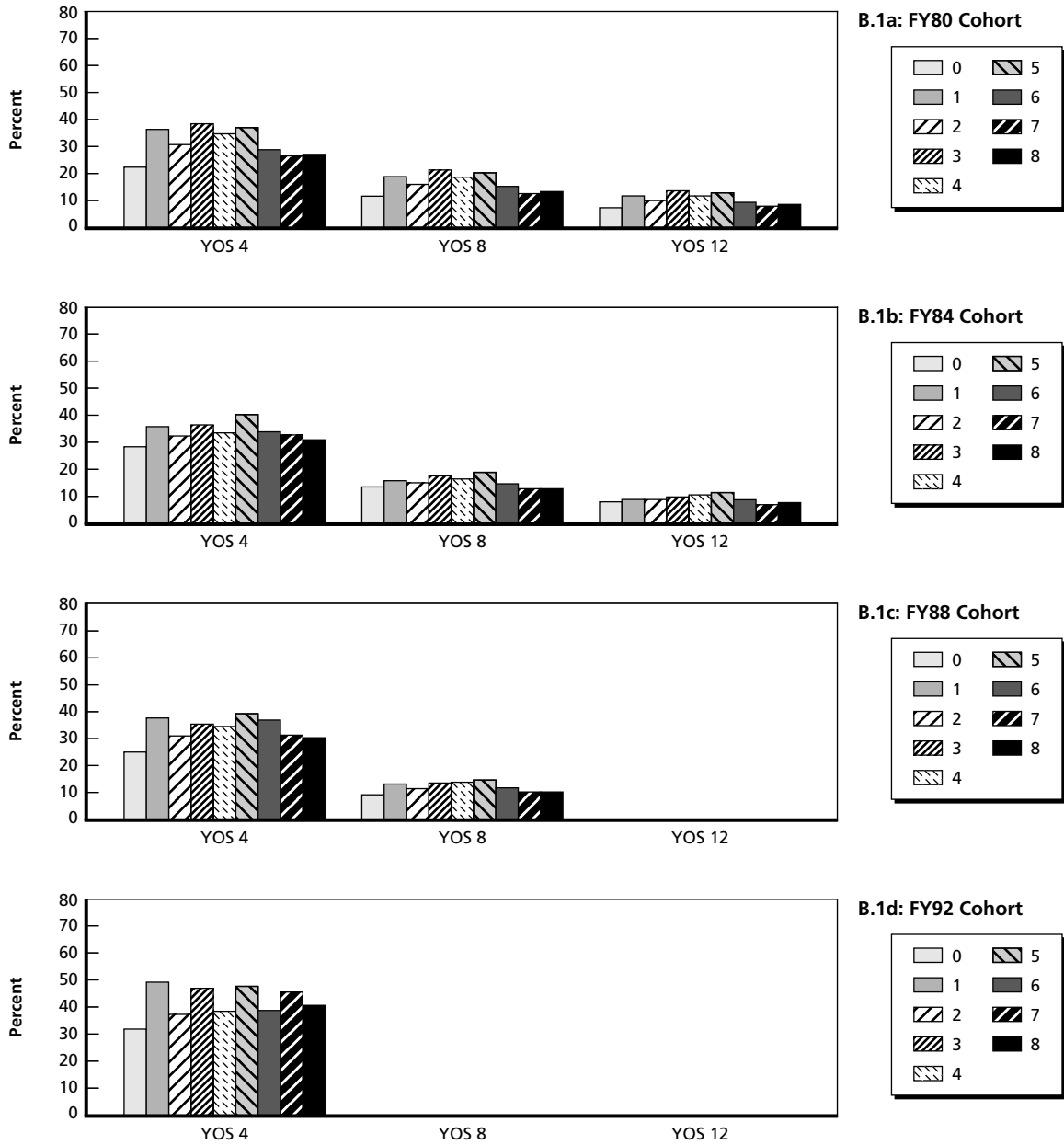
Although the YOS 4 point only roughly corresponds with the first reenlistment point,<sup>1</sup> the trends across service and entry cohort through YOS 4 are largely consistent with the retention trends into the second term shown for occupational groups 5 and 6 in Figures A.3a through A.3f in Appendix A. For example, both Figures A.3a through A.3f and Figures B.1a through B.4d show that a relatively high fraction of personnel are retained at YOS 4 in the Air Force and Navy while a smaller fraction are retained through YOS 4 in the Army and Marine Corps.<sup>2</sup> Figures B.1a through B.4d show that about 45 to 55 percent of those who enter the Air Force are retained through YOS 4. About 50 to 60 percent of those who enter the Navy are retained through YOS 4 among the early cohorts, with the retention rate declining among later cohorts. In contrast, the corresponding figure for the Army is about 35 percent, and the figures for the Marine Corps ranges from 25 to 50 percent.

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<sup>1</sup> Personnel with two- or three-year terms of enlistment will have made a reenlistment decision before YOS 4, and the percentage still present at YOS will only be slightly smaller than the percentage that reenlisted. This is because attrition rates during the second term are low, perhaps five percent per year.

<sup>2</sup> For occupational groups 5 and 6, the Army's retention rate eclipsed that of the Navy beginning in FY90.

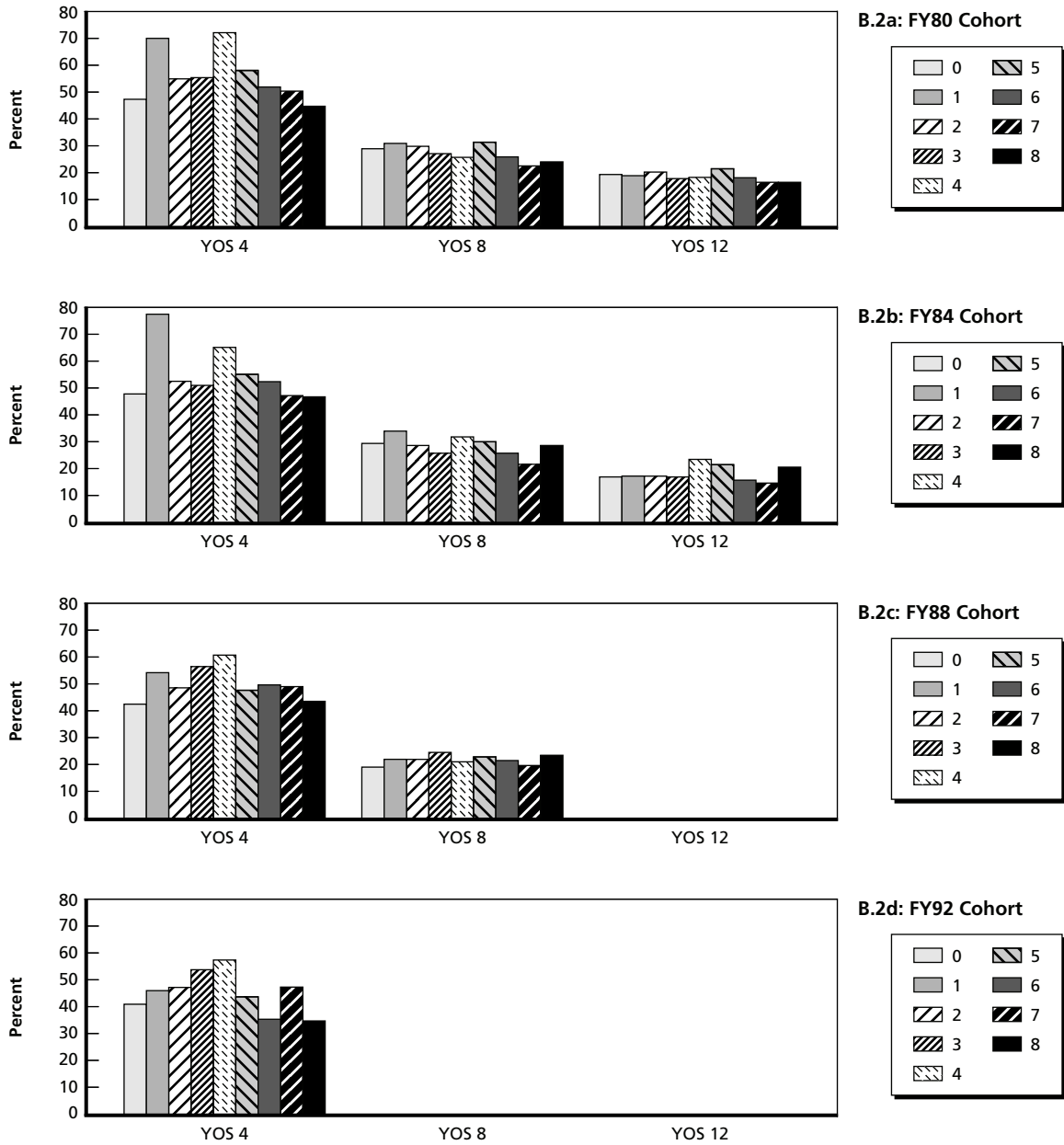
**Figure B.1**  
**Army Retention Rates by One-Digit Occupation Code, at YOS 4, YOS 8, and YOS 12, by Cohort**



SOURCE: Authors' calculations using the DMDC DSCAC file.

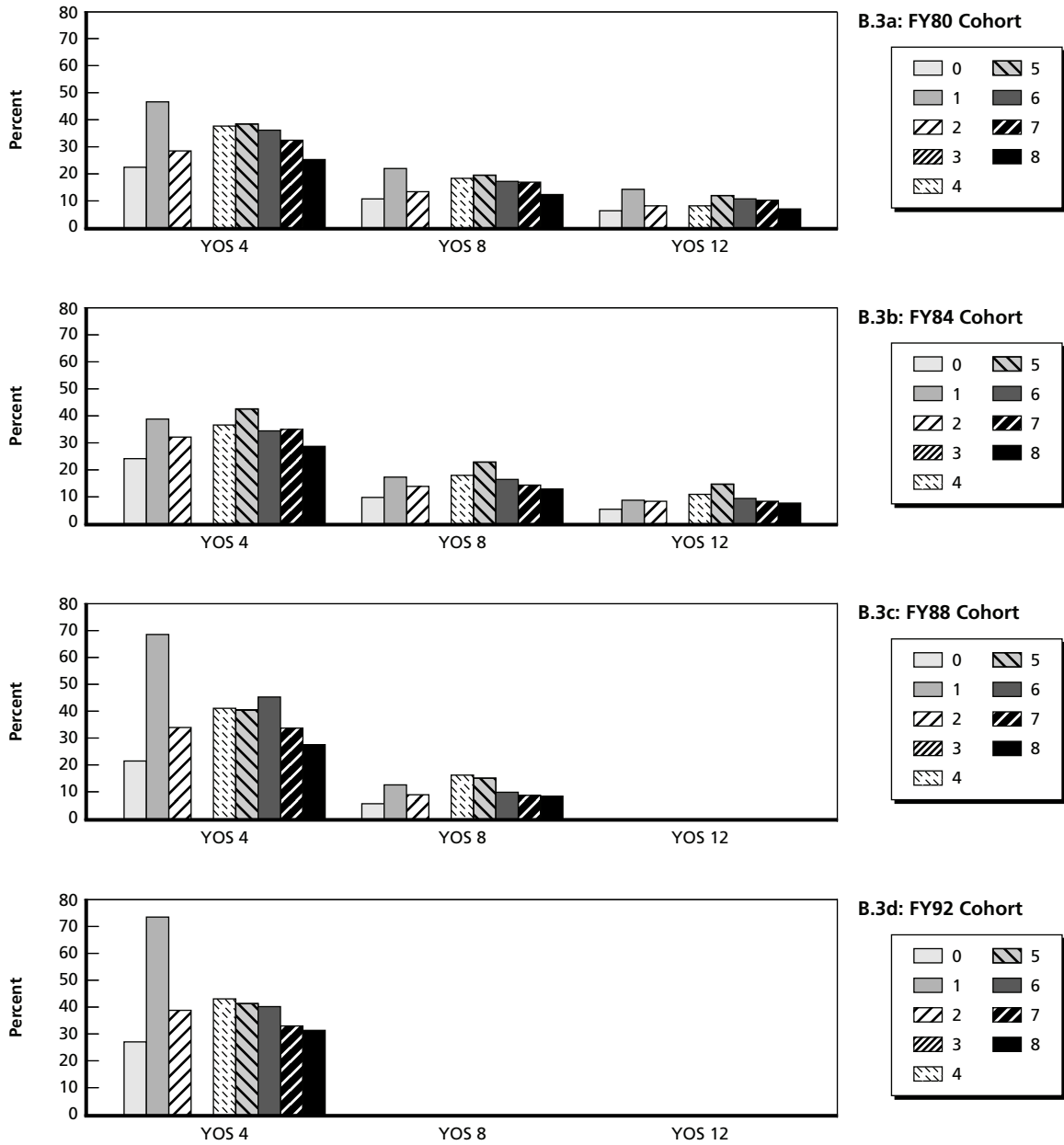
RAND MG324-B.1

**Figure B.2**  
**Navy Retention Rates by One-Digit Occupation Code, at YOS 4, YOS 8, and YOS 12, by Cohort**



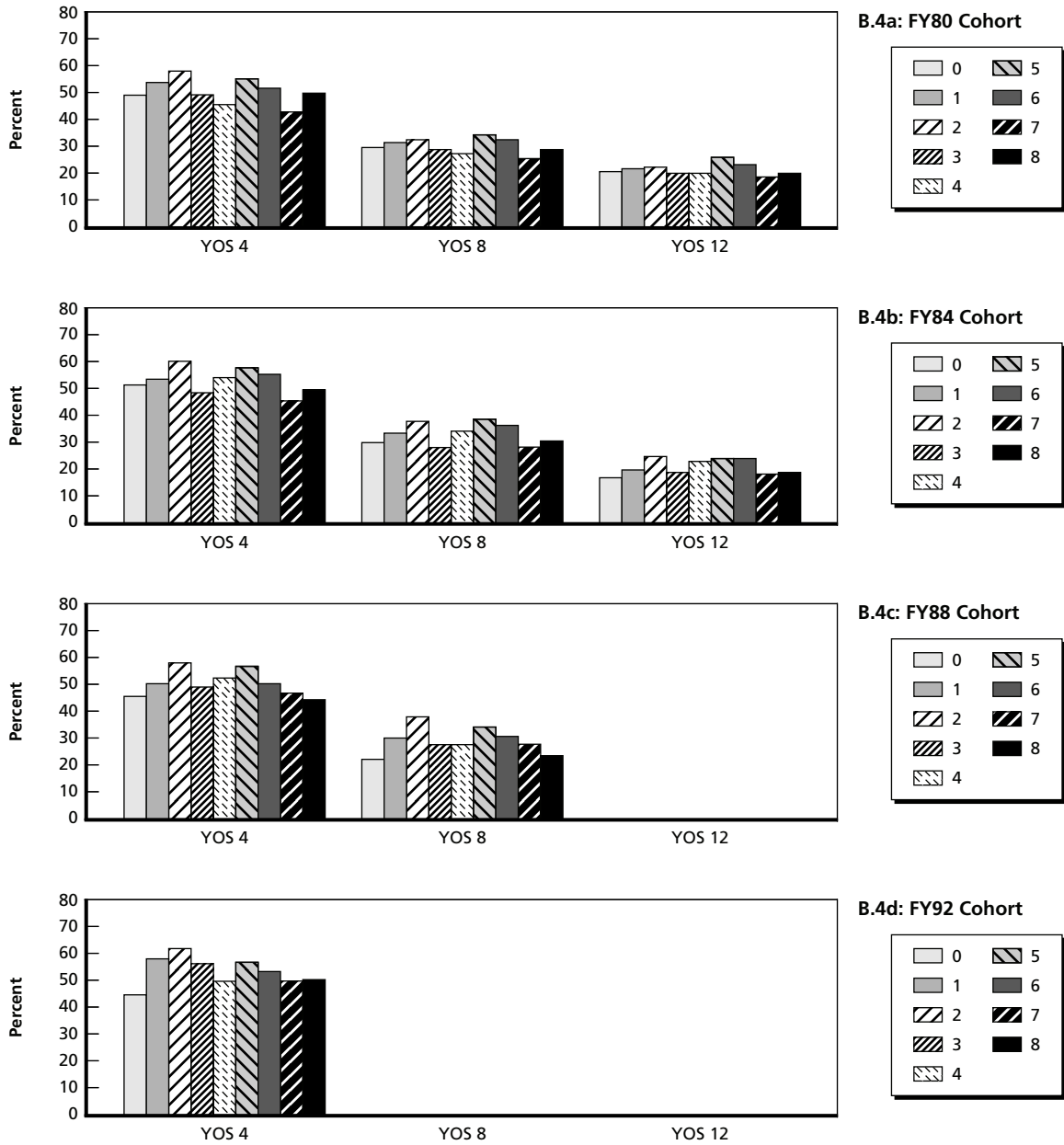
SOURCE: Authors' calculations using the DMDC DSCAC file.  
 RAND MG324-B.2

**Figure B.3**  
**Marine Corps Retention Rates by One-Digit Occupation Code, at YOS 4, YOS 8, and YOS 12, by Cohort**



SOURCE: Authors' calculations using the DMDC DSCAC file.  
 NOTE: The Marine Corps does not have an occupational area 3, medical and dental specialty.  
 RAND MG324-B.3

**Figure B.4**  
**Air Force Retention Rates by One-Digit Occupation Code, at YOS 4, YOS 8, and YOS 12, by Cohort**



SOURCE: Authors' calculations using the DMDC DSCAC file.  
 RAND MG324-B.4

Retention rates through YOS 8 and YOS 12 are similar across cohorts within a service, and there are persistent differences across services. Figures B.1a through B.4d indicate that about 15 to 20 percent of the entry cohort stays until YOS 8 in the Army and Marine Corps, while about 30 percent stays until YOS 8 in the Navy and Air Force. This retention rate declined to about 20 to 25 percent for the Navy's FY88 cohort. By YOS 12, about 10 percent of those who enter the Army or Marine Corps remain in service, while about 20 percent of those who enter the Navy or Air Force are still in service.

The figures also indicate some variation in early and midcareer retention rates across occupational areas. Consistently, we find that the infantry, gun crews, and seamanship occupational area and the craftsmen area (occupational areas 0 and 7, respectively) tend to have low retention rates. In contrast, the electronic equipment repair, medical and dental specialty, and the functional support and administration areas (occupational areas 1, 3, and 5, respectively) have relatively high rates. Retention of these occupational areas is similar in relative terms across services. For example, at YOS 4, the FY80 cohort retention rate for occupational area 0 (infantry, gun crews, and seamanship) was 23 percent in the Army, 48 percent in the Navy, 23 percent in the Marine Corps, and 49 percent in the Air Force. In contrast, the FY80 cohort retention rates at YOS 4 for occupational area 1 (electronic equipment repairer) was 36 percent, 70 percent, 47 percent, and 54 percent for each service, respectively. Therefore, the occupational area 1 YOS 4 retention rates for the FY80 cohort were about 50 to 100 percent higher than the occupational area 0 rates for the Army, Navy, and Marine Corps.

The differences in retention rates across occupational areas generally decline with YOS in absolute terms, although not always in relative terms. For example, the differences between occupational area 0 and occupational area 1 retention rates in the Army FY80 cohort fall from 13 percentage points at YOS 4 (i.e., 36 percent minus 23 percent) to seven percentage points at YOS 8 and five percentage points at YOS 12. However, in relative terms, the seven-point difference at YOS 8 and the five-point difference at YOS 12 represent a 60- to 70-percent difference, a bigger percentage difference than at the YOS 4 point.

Although Figures B.1a through B.4d show variation in retention rates across occupational area, the profiles within each service are nonetheless quite similar for a given cohort. Regardless of occupational area, retention drops off substantially at YOS 8 relative to YOS 4, and then drops again at YOS 12 relative to YOS 8. Therefore, despite the variations across occupational areas, occupational areas exhibit similarity in retention rates through YOS 12.

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