

Retaining the Army's Cyber Expertise

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Key findings

- Despite the restrictive requirements for qualification, the Army has a large pool of potential 17C Cyber MOS applicants every year.
- Soldiers who qualify for 17C are more likely than others to remain in the Army through their first term, but they also appear to be somewhat less likely to reenlist.
- The civilian occupation of information security analyst has substantial overlap with 17C duties and attracts many veterans.
- Soldiers who do not reenlist may pursue civilian careers as information security analysts, but despite higher wages than many other occupations, information security analysts similar to enlisted soldiers have projected earnings comparable with military pay.
- Data indicate the median pay for information security analysts with a college degree is considerably higher than Army enlisted compensation.
- Actual wages of civilian cyber security analysts may not match soldiers' perceptions.
- Retention efforts may be seriously hampered by the perceptions young enlisted soldiers might have regarding their civilian opportunities outside the Army.

SUMMARY ■ In 2014, the Army established the Cyber career field as a basic branch, which includes the 17C military occupational specialty (MOS) for enlisted cyber operations specialists. These soldiers require extensive training, and Army leadership is concerned that they will be lured away by lucrative jobs in the civilian labor market. This report describes a subset of the results from a RAND Arroyo Center study, sponsored by the United States Army Intelligence and Security Command (INSCOM). Specifically, the report includes quantitative findings regarding the historical retention of recruits with similar qualifications as cyber operations specialists and the wage earnings available to cyber operations specialist soldiers in the civilian sector. These findings will help inform the Army's strategy for retaining these 17C soldiers.

In this report, we focus on issues related to retaining cyber soldiers. We use data from the Army's personnel files to determine how many new soldiers are likely to meet the qualifications for this new MOS, as well as their expected retention rates. Specifically, we apply 17C enlistment requirements to all soldiers to determine how many meet the standards. We also use data on civilian occupations to determine the earnings these soldiers are likely to be offered based on their military cyber training. To do this, we use the American Community Survey (ACS) data on all workers in information technology (IT)-related occupations. We also focus on the subset of specific

jobs with the largest overlap with 17C tasks, and on workers whose demographic characteristics are similar to those of soldiers. Finally, we examine both means and distributions to gain a better

understanding of how civilian wages compare with Army pay. We conclude with a short discussion of tools and options for retaining cyber soldiers in the Army, as well as a discussion of the implications of our findings.

Although 17C has among the most restrictive requirements for qualification, the Army has a large pool of potential 17C applicants every year. Soldiers who qualify for 17C are more likely than others to remain in the Army for at least 72 months; however, they also appear to be somewhat less likely to reenlist. One particular civilian occupation—information security (InfoSec) analyst—has substantial overlap with 17C duties and attracts many veterans. Therefore, soldiers who do not reenlist may pursue civilian careers as InfoSec analysts. Although InfoSec analysts have higher wages than many other occupations, projected earnings for InfoSec analysts are comparable with military pay, when looking at workers with characteristics similar to those of enlisted soldiers. However, the data indicate that the median pay for InfoSec analysts *with* a college degree is considerably higher than Army enlisted compensation.

It is important to note that our analysis focused on the actual wages of InfoSec analysts, not the wages that 17C soldiers perceive InfoSec analysts have. Retention efforts may be seriously hampered by the perceptions young enlisted soldiers might have regarding their civilian opportunities outside the Army.

Recommendations for Managing Army Cyber

Occupations: The soldiers likely to qualify for 17C have higher continuation rates than the average soldier. Given that continuation rate is strongly tied to the length of initial obligation, a long initial obligation is an important retention tool. Past research indicates that new service members are not very sensitive to the initial contract length, which suggests that the Army should retain its long initial obligation requirements for 17C for the foreseeable future.

Given that military pay for soldiers near the end of their first term is comparable with the median pay of likely jobs in the civilian sector, retention tools like selective reenlistment bonuses (SRBs) and special pay can go a long way toward tipping the scales in favor of staying in the Army.

Existing research strongly suggests that tracking civilian compensation and hiring will play an important role in managing Army cyber occupations; if civilian compensation, the value of Army-provided training, or soldiers' experiences in Army cyber occupations change, then adjustments to compensation may be required to manage these occupations in the most effective manner possible. Given the current civilian pay available, existing tools likely can be used to effectively manage 17C. Bonuses are one example of such a tool. However, ongoing analyses should include careful tracking of successful training completion and retention rates, as well as civilian pay and demand for InfoSec analysts in the civilian sector. This information will play an important role in managing this occupation.

INTRODUCTION

On August 21, 2014, the Secretary of the Army signed General Order 2014-63, establishing the Cyber career field (career

Abbreviations

ACS	American Community Survey
AFQT	Armed Forces Qualification Test
ASVAB	Armed Services Vocational Aptitude Battery
CMF	Career Management Field
DCO	defensive cyber operations
DoD	Department of Defense
FY	fiscal year
GT	General Technical
InfoSec	information security
INSCOM	U.S. Army Intelligence and Security Command
IT	information technology
MOS	military occupational specialty
OCO	offensive cyber operations
RA	regular Army
RMC	regular military compensation
SRBs	selective reenlistment bonuses
SSBI	Single Scope Background Investigation
ST	Skilled Technical
TAPDB	Total Army Personnel Database

management field [CMF] 17) as a basic branch of the Army.¹ The Cyber branch has the mission to conduct defensive cyber operations (DCO) and offensive cyber operations (OCO). DCO protects data, networks, net-centric capabilities, and other designated systems through detection, identification, and response actions to attacks against friendly networks. OCO projects power through the application of force in and through cyberspace to target hostile adversary activities and capabilities.² The Cyber branch is composed of occupational specialties for officers (17A, cyber warfare officers; 17X, cyber operations officers), warrant officers (170A, cyber operations technician warrant officers), and enlisted personnel (17C, enlisted cyber operations specialists).

To build its 17C workforce, the Army is pulling talent from within the Army as well as growing new talent from those entering the Army. For example, the Army initially focused on pulling enlisted personnel into 17C from three units: the 780th Military Intelligence Brigade, the 7th Cyber Protection Brigade, and the Joint Force Headquarters–Cyber.³ However, soldiers not assigned to those units but interested in 17C have been allowed to separately apply to reclassify into the 17C military occupational specialty (MOS). The Army plans to recruit individuals as well, thus merging personnel with Army experience and individuals with little or no military experience.

As it builds its 17 CMF workforces, the Army is also investing in new training and retention programs. Because of the technical nature of cyber work, personnel will be provided extensive training. Given this training investment, Army leadership is concerned that the Army will have difficulty retaining cyber talent because personnel will be lured by lucrative cyber jobs in the civilian labor market. If retention is a challenge, the Army will need to consider strategies to retain cyber talent. Given the issues of training and retention, INSCOM asked the RAND Arroyo Center to determine whether the Army is cost-effectively training its 17 CMF personnel and recommend changes to training and/or retention strategies to maximize benefits while minimizing costs. In consultation with the sponsor, RAND Arroyo Center's study focused on the largest 17 CMF workforce: cyber operations specialists (17C MOS). Besides its size, the 17C workforce was selected for the study because it is unclear how the educational and training experiences of enlisted soldiers in a technical field such as cyber will be rewarded in the civilian sector. While returns to college in the civilian sector are well documented, the extent to which civilian employers seeking the skills likely to be found in Army

cyber training are willing to hire those without college degrees is an open question that we explore in this report.

We also present results from an analysis of Army personnel data to assess potential retention issues for the new 17C specialty. This analysis poses empirical challenges, as the first class of 17C soldiers is not expected to complete training until fall of 2017. Therefore, we have no historical data on the performance of 17C soldiers. Instead, we use data from the Army's personnel files to determine how many new soldiers are likely to meet the qualifications for this new MOS, as well as their expected retention rates. We also use data on civilian occupations to determine the earnings these soldiers are likely to be offered based on their military cyber training. We conclude with a short discussion of tools and options for retaining cyber soldiers in the Army, as well as a discussion of the implications of our findings.

QUALIFYING FOR CYBER OPERATIONS SPECIALIST MOS

Each Army MOS has its own entrance criteria. These criteria generally include standardized test scores, education credentials, mental and physical health, and specific service obligations. The specific requirements, especially required minimum scores on standardized tests, differ substantially across career fields and MOSs.

17C MOS Has Some of the Most Stringent Entrance Criteria

The 17C MOS includes the same *types* of criteria as most other Army occupations, but many of the entrance criteria are more *stringent* than is the case for most other MOSs. Specifically, entry into 17C requires the following:

- high school diploma or equivalent credential (sometimes referred to as *Tier 1* credential)
- citizenship
- ASVAB line scores of at least 112 in the Skilled Technical (ST) area *and* at least 110 on the General Technical (GT) area⁴
- ability to hold a Top Secret clearance with sensitive compartmented information access⁵
- obligation of five years, *after* completion of training.

While most soldiers are high school diploma graduates and citizens, the line scores required to enter 17C substantially restrict the pool of soldiers who qualify. To examine the effects

of specific criteria more closely, we compared the proportion of enlistees who meet the 17C criteria with the proportion who meet entrance criteria for other relevant occupations. We chose this group of relevant occupations by focusing on occupations that have key attributes in common with 17C; in particular, we selected a group of occupations that either utilize similar skills or involve similarly lengthy training pipelines. Table 1 lists our comparison group, along with a subset of entry criteria for each MOS.⁶ The comparison occupations have similar types of requirements to those of 17C (e.g., the majority of our comparison occupations require specific scores on the ST test). However, the minimum score requirements are more stringent for 17Cs than for the comparable MOSs.

Among Comparable MOSs, 17C Has Smallest Subset of Qualified Enlistees

Using Army personnel data, we were able to quantify the differences in entry criteria and determine what proportion of new enlistees meet the entrance criteria for each of the MOSs

detailed in Table 1. We included all non–prior service enlisted accessions who entered the regular Army between fiscal year (FY) 2001 and FY 2015.⁷ Based on these data, Figure 1 shows the percentage of enlistees who would qualify for each MOS over that time period.

As shown in Table 1, most MOSs considered require an education credential, as well as citizenship and the ability to hold a clearance. The vast majority of new soldiers hold a high school diploma or equivalent credential; over the period FY 2001 to FY 2015, only 13 percent of new enlistees lacked such an education credential. During the same period, nearly 97 percent of new enlistees were citizens. Determining how many new soldiers could hold a Top Secret security clearance is more difficult. We use an absence of key waivers as a rough proxy for the ability to hold a clearance; we expect that the proportion with waivers is an underestimate of the proportion of soldiers who cannot obtain a clearance.⁸ However, these waivers are not very common among soldiers either. In essence, the test score requirements explain much of the variation in the percentage of qualified new accessions shown in Figure 1.

Table 1. Comparison Occupations Have Similar Types of Requirements to the Entry Criteria for Cyber Operations Specialists (17C)

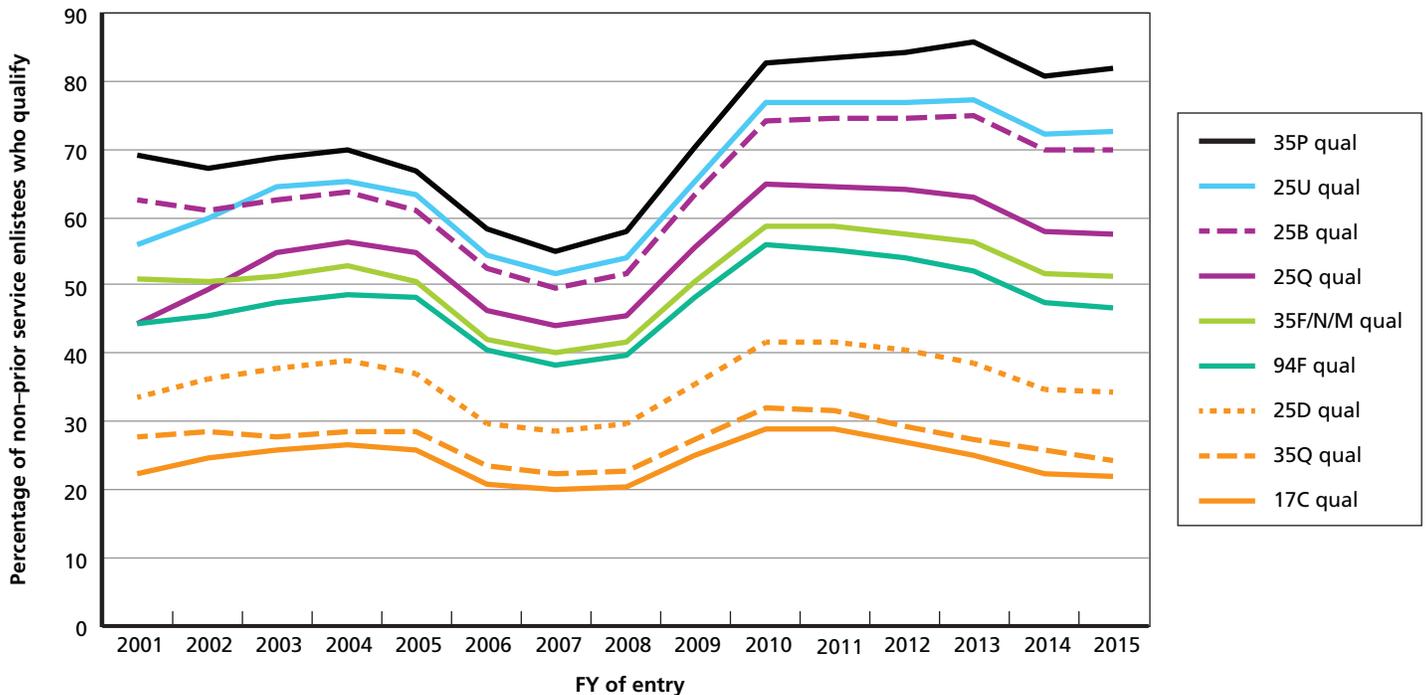
MOS	Title	Skilled Tech Line Score	General Tech Line Score	Electronics Line Score	Surveillance and Comm Line Score
17C	Cyber Ops Specialist	≥ 112	≥ 110		
35Q	Crypto Network Warfare Spec	≥ 112			
25D	Cyber Network Defender	≥ 105	≥ 105		
94F	Computer Detect Sys Repair			≥ 102	
35F	Intel Analyst	≥ 101			
35M	Human Intel Collector	≥ 101			
35N	Signals Intel Analyst	≥ 101			
25Q	Multichannel Sys Op			≥ 98	≥ 98
25B	Info Tech Specialist	≥ 95			
25U	Signal Support Sys Spec			≥ 93	≥ 92
35P	Cryptologic Linguist	≥ 91			

NOTES: Entry criteria from GoArmy.com.

MOSs listed require high school diploma or equivalent, citizenship, and the capability to obtain a security clearance. However, note that 94F does not explicitly require a high school diploma.

ST, GT, Electronics, Surveillance & Comm(unications) line scores are derived from combinations of the Armed Services Vocational Aptitude Battery (ASVAB) subscores. Those entering the 35Q MOS must also pass the Information/Communication Technology Literacy test. Similarly, those entering the 35P MOS must also meet a minimum requirement on Defense Language Aptitude Battery.

Figure 1. Test Score Requirements Explain Much of the Variation in the Percentage of Enlistees Qualifying for Various MOSs



SOURCE: RAND Arroyo Center analyses based on Army personnel data for enlisted accessions, FY 2001–FY 2015.

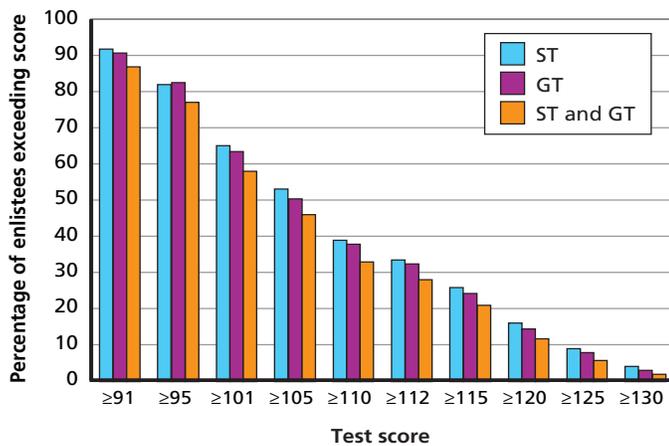
In the case of 17C, the vast majority of soldiers who enter the Army do *not* meet the requirements to serve in the MOS. However, with the number of non–prior service accessions over this period varying between 55,000 and 80,000, a qualification rate between 22 and 31 percent indicates that the Army has far more enlisted personnel who qualify for 17C each year than would realistically be required in this MOS. Moreover, there is little evidence that the requirements are binding across the occupations listed in Table 1 and Figure 1. Just over half of all soldiers qualify for the 35F/35M/35N occupations, for example, but far fewer soldiers initially enter one of those occupations, and these MOSs are among the largest in the group we examine. In general, the occupations shown in Table 1 and Figure 1 are quite small, and many more soldiers than are necessary qualify. Qualification based on test scores, education credentials, and lack of waivers is not sufficient, of course, to determine that an MOS will have sufficient personnel. Soldiers also must also wish to work in the field, choose to enter the MOS, and be willing to go through the clearance process. Finally, they must also successfully complete long and rigorous training. The size of the likely qualified pool suggests that at least the potential supply is likely to exceed the near-term requirement by a generous

amount. However, continuing to ensure sufficient supply for key MOSs requires continual monitoring of ASVAB test scores and line scores.

Given the central importance of the test score criteria in determining the number who qualify to enter 17C, understanding more about the distribution of line scores among enlistees is likely to be helpful in determining whether the potential supply is sufficient under various enlistment criteria. Figure 2 indicates the percentage of new enlistees who exceed various ST and GT line scores, as well as the percentage of new enlistees who exceed *both* the ST and the GT scores.

Recall that the current requirements to enter 17C are a score of 112 on the ST and of 110 on the GT. Figure 2 indicates that about 38 percent of new enlistees score at least 110 on the GT, while about 34 percent score at least 112 on the ST. The correlation between these two tests is high; about 30 percent of new enlistees score at least 112 on the ST *and* at least 110 on the GT.⁹ Given that the average number of enlistees per year is roughly 60,000, Figure 2 suggests that even at higher ST and/or GT cutoffs, there would be relatively large numbers of soldiers who met the criteria.

Figure 2. About 38 Percent of New Enlistees Score at Least 110 on the GT, While About 34 Percent Score at Least 112 on the ST



SOURCE: RAND Arroyo Center analyses of Army personnel data for enlisted accessions, FY 2001–FY 2015.

Concluding Observations

Although 17C has among the most restrictive requirements for qualification, the Army has a large pool of potentially suitable applicants every year, with more than 10,000 soldiers in FY 2015 alone meeting the education, testing, and citizenship requirements and lacking waivers that would likely interfere with clearance eligibility.

RETENTION IN CYBER-RELEVANT OCCUPATIONS

Because 17C is a new MOS, we do not have sufficient data to measure the longer-term retention rates among soldiers who entered the Army and immediately began training in the 17C occupation. Similarly, the 35Q MOS was only established in FY 2013, so this closely related MOS also has insufficient data to study longer-term retention rates. However, we do have a substantial amount of information on soldiers who *qualify* for 17C, as well as soldiers who serve in other cyber-relevant occupations. As in the previous chapter, we utilize Army personnel data, but here our focus is on measures related to retention or continuation.

Attrition and Continuation Rates Among 17C-Qualified Soldiers

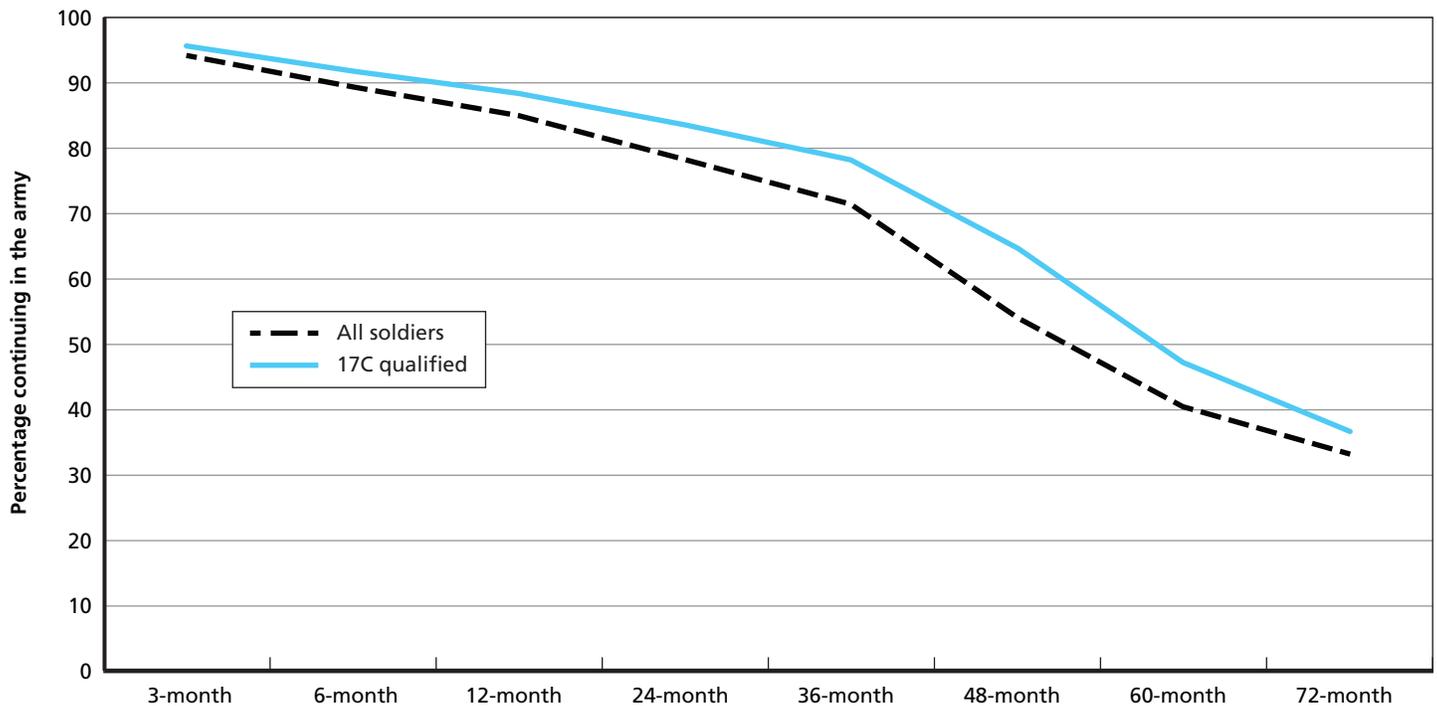
Within the military manpower community, completion of the first enlisted term is viewed as a primary performance measure because those who *attrite*, or do not complete a first term, represent lost recruiting and training resources (on average, producing one trained recruit costs \$70,000).¹⁰ Here, we use the term *attrition* to refer specifically to exit from the Army before completing the first term, in a manner that is thought to fall partly or completely under the control of the soldier; such attrition is often referred to as resulting from a *failure to adapt* to Army life.¹¹ We use the term *continuation* to capture a broader concept—during the first term, continuation simply implies that the soldier did not attrite; after the end of the first term, continuation implies that the soldier remains in the Army (generally through reenlistment). Therefore, attrition measures first-term performance, while continuation measures the length of time the soldier remains on active duty. Attrition, as a primary performance measure, has been widely studied.

Certain recruit characteristics are associated with attrition; in particular, education level is strongly predictive of first-term attrition. Service members who possess a traditional high school diploma have lower levels of attrition, and thus are substantially more likely to complete their first term, than those who enter the services with no recognized degree or General Educational Development (GED) certificate. Likewise, enlistees with college experience have a lower attrition rate than those who have never attended college. Men have lower attrition than women, on average. Older recruits have been found to have lower attrition as well. In general, test scores are viewed as measures of trainability; however, they have been found to have a modest relationship to first-term attrition.¹²

It is worth noting that some characteristics associated with low levels of first-term attrition also correlate with relatively low levels of reenlistment (and, thus, with relatively low levels of continuation past the first term). For example, enlisted recruits with college degrees have low first-term attrition rates but have also been found to reenlist at relatively low rates.¹³ Given the very long training pipeline and the substantial costs associated with training a 17C soldier, the Army needs to understand as much as possible about the likely continuation rates to ensure there is sufficient return on its training investment.

Figure 3 tracks the continuation rates of soldiers in our data set.¹⁴ The dashed black line indicates the continuation rate of all Army enlistees over time. The slope of the line over the first three years reflects primarily (failure to adapt) attrition;

Figure 3. The Continuation Rate Among 17C-Qualified Soldiers Is Somewhat Higher Than the Rate Among All Soldiers



SOURCE: RAND Arroyo Center analyses of Army personnel data.

after 36 months, the line drops off as soldiers begin to leave the Army upon completing their initial obligation, with more soldiers leaving over the next few years. The solid blue line indicates the continuation rate of soldiers likely *qualified* for 17C. We determined qualification exactly as described in the section on qualifying for the 17C MOS. Note that none of these soldiers actually serves in 17C, as we lack long-term information about this MOS, but these soldiers likely meet the criteria to serve in that MOS, so their behavior may be relevant for estimating future behavior of 17C soldiers.¹⁵ The continuation rate among 17C-qualified soldiers is somewhat higher than the rate among all soldiers. The initial differences (those that occur during the first 36 months) suggest that these soldiers—who generally have higher levels of education—have lower attrition early in the first term than enlistees in general. (This is consistent with the literature on attrition.) Overall, Figure 3 suggests that soldiers in 17C are likely to have higher continuation rates over the early months than other soldiers. We note that aspects of the MOS (e.g., receiving valuable training, performing meaningful work, limited deployment opportunities, etc.) also have the potential to influence continuation rates.

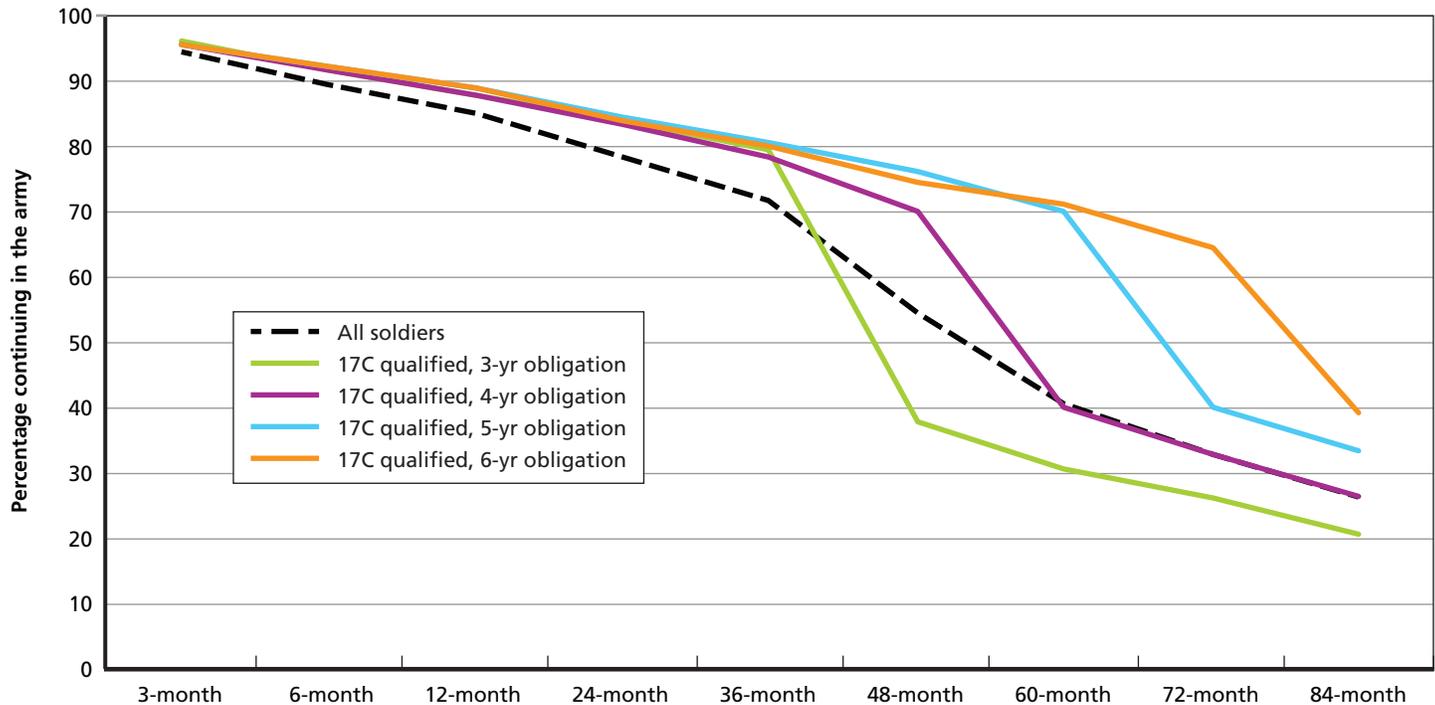
The most common exit point among enlisted soldiers is at the end of the initial obligation.¹⁶ Therefore, initial obligation is a driver of continuation rates, although it has far less influence

on attrition within the initial months after joining the Army. In our data set, the most frequent initial obligations are three and four years, with less than one-quarter of soldiers having a longer initial obligation (e.g., five or six years). This suggests that many of the soldiers in our data set may exhibit somewhat different behavior from that found in the 35Q and 17C MOSs, both of which entail long initial obligations. Therefore, we are careful to consider initial obligation when exploring the relationships between personal characteristics (including test scores) and continuation rates.

In Figure 4, we again trace out the continuation rate of all soldiers, but now we separate the 17C-qualified soldiers depending on their initial obligation. Figure 4 demonstrates again that soldiers who are qualified for 17C have higher continuation rates over the first 36 months than others; therefore, the solid lines are all above the black dotted line for the first 36 months. This suggests that, consistent with the literature, those soldiers who qualify for 17C have relatively low levels of failure to adapt attrition. Figure 4 also demonstrates that continuation rates fall for each group upon reaching the end of the initial obligation and indicates that initial obligation is the key driver for differences in continuation rates after 36 months.

Using these data, we estimated a straightforward regression model of continuation. The results indicate that, even when we

Figure 4. Soldiers Qualified for 17C Have Higher Continuation Rates over the First 36 Months Than Others

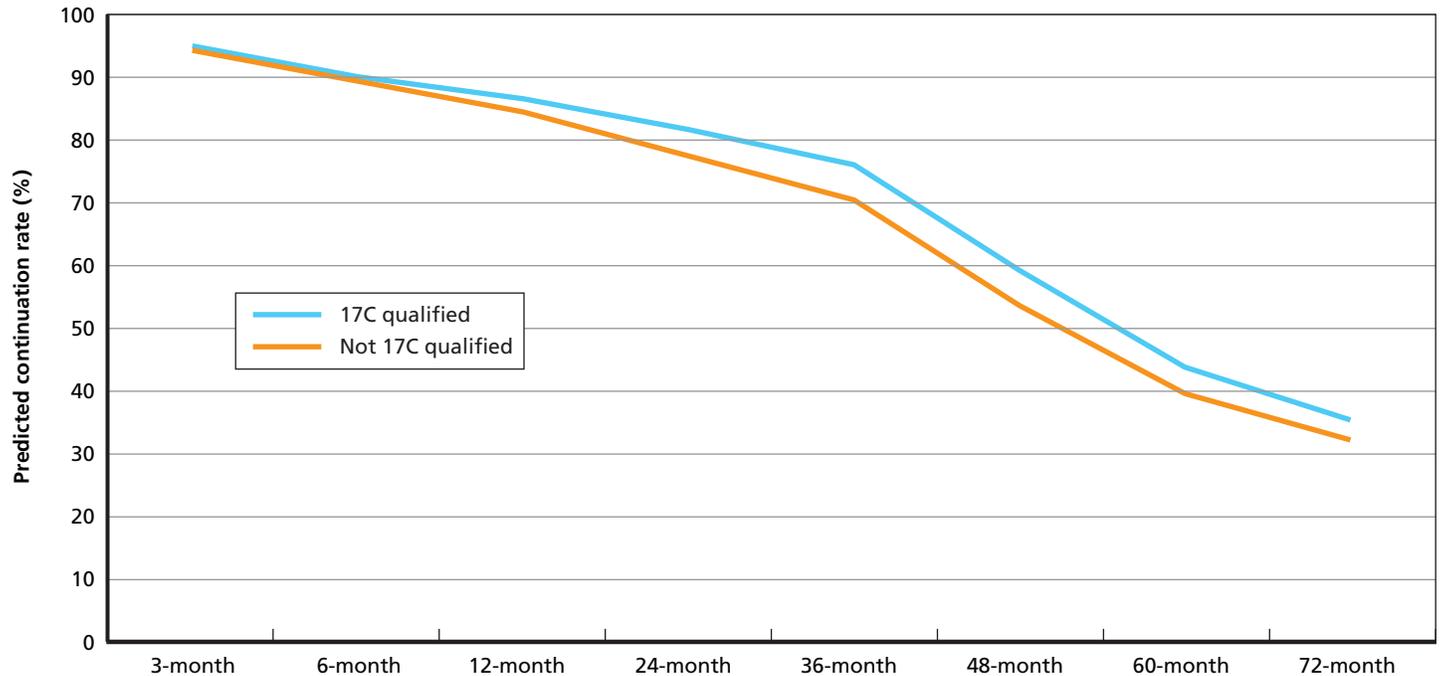


SOURCE: RAND Arroyo Center analyses of Army personnel data.

compare soldiers with the same initial obligations, those who likely qualify for 17C have higher continuation rates than others at each point between three and 72 months.¹⁷ Figure 5 includes the predicted differences in continuation rates for soldiers who do and do not qualify for 17C. The predicted differences indicate the size of the *marginal effects*—the differences in continuation or attrition that are correlated with qualifying for 17C while holding other factors constant. These differences are substantial and increase steadily from three to 36 months; at the end of 36 months, 17C-qualified soldiers are about 6 percentage points more likely to remain in the Army than otherwise-similar soldiers who do not meet the 17C requirements captured in this analysis. Overall failure to adapt attrition is about 21 percent for the entire sample; thus, soldiers who qualify for 17C have lower attrition rates over the first 36 months than other soldiers. Even during the first months of a soldier’s contract, those who are qualified for 17C have continuation rates 1 to 2 percentage points higher (equivalently, attrition rates 1 to 2 percentage points lower) than other similar soldiers. While this may appear small, such differences have financially significant consequences. Recall that recruiting and training one soldier is estimated to cost \$70,000.¹⁸ Even increasing continuation by 1 percentage point means that at

least 600 additional soldiers remain in the Army (depending on the overall recruiting mission in a given year). Given that about 10 percent of soldiers attrite for failure to adapt reasons in the first six months, increasing six-month continuation rates by 1 percentage point also represents a 10-percent decrease in failure to adapt attrition rates (a drop from 10 percent to 9 percent). Therefore, even small differences in continuation and attrition are consequential. After 36 months, the differences actually decrease; this suggests the soldiers who qualify for 17C are much less likely than others to attrite over the first 36 months of service and somewhat less likely to continue in the Army over the next 36 months.¹⁹ This is consistent with these soldiers reenlisting at lower rates than other soldiers (although we do not model reenlistment explicitly). However, the overall net effect is that soldiers who qualify for 17C are more likely than others to remain in the Army for least 72 months, and this is the case regardless of initial obligation length. Thus, our results are not driven by soldiers who qualify for 17C selecting MOSs with longer initial obligations; rather, characteristics of the soldiers themselves appear to be linked to low levels of attrition, and this effect is large enough to outweigh differences in initial reenlistment.

Figure 5. At the End of 36 Months, 17C-Qualified Soldiers Are More Likely to Stay in the Army Than Otherwise-Similar Soldiers



SOURCE: RAND Arroyo Center analyses of Army personnel data. Predicted continuation rates based on regression analyses; also see Appendix B, Table 2.

Concluding Observations

Soldiers who qualify for 17C are more likely than others to remain in the Army for at least 72 months; however, they also appear to be somewhat less likely than others to continue past the end of their first term. Continuation rates are strongly tied to the length of initial obligation, and the data suggest that the Army should retain its long initial obligation requirements for 17C for the foreseeable future.²⁰

CYBER-RELEVANT OCCUPATIONS IN THE CIVILIAN SECTOR

As discussed in the previous section, soldiers who qualify for 17C are much less likely than others to attrite and somewhat less likely to reenlist. It is at this point of reenlistment that many in Army senior leadership fear the opportunities afforded by the private sector are likely to lure talented cyber specialists away from military service.

Past Experiences in Managing Highly Trained Personnel

The 17C MOS requires a large amount of highly specialized training likely to have value in the civilian labor market. Therefore, retention beyond the first term is a source of concern by those designing and managing this new MOS. Understanding the likely civilian occupations of 17C soldiers, and their civilian compensation, will be valuable in working to manage the occupation.

First, we note that the services have significant experience retaining highly trained personnel who are sought after in the civilian sector. Examples include sailors serving in the nuclear fields and aircraft pilots. Retention in these fields has been costly at times and has required active management and careful tracking of retention rates; we expect this will also be the case for 17C.

Past experience in the IT fields is likely to be especially relevant to the 17C MOS. In the late 1990s, concerns about service members in IT fields were similar to the concerns currently expressed about cyber personnel today. At that time, those referred to as IT workers had high levels of training and technical expertise; there was significant demand and rising wages for workers with these skills in the civilian sector. Previous research

indicates that the services were fairly successful at retaining IT personnel during this period, although outside opportunities certainly influenced retention for many technical positions.²¹ During this period, bonuses were an important retention tool, but creating and fulfilling an expectation that service members would receive additional valuable training during the reenlistment period was also key to retention.²² Other research suggests that aspects of work not related to pay, such as job satisfaction and training opportunities, are viewed as keys to successful retention in the civilian sector as well.²³

Although there are factors aside from monetary ones that influence a soldier's decision to reenlist, the Army should be aware of the pay available in the civilian sector and how it compares with military pay and benefits.

Civilian Alternatives for Cyber Operations Specialists

The source of our information about civilian cyber jobs is the ACS. The ACS is a large, representative data set that includes a wide variety of information on earnings and detailed information on occupations, as well as information on geographic location, housing characteristics, family structure, experiences with unemployment, and many other facets of life. The ACS includes information on those who work in the private sector (for-profit and nonprofit firms), as well as those who work for all levels of the government (local, state, federal).

Our analysis focuses primarily on InfoSec analysts, as this occupation has substantial overlap with the job duties and qualifications of those in the 17C MOS. In the civilian sector, information security analysts plan and carry out security measures to protect an organization's computer networks and systems.²⁴ Despite the large size of the ACS, the number of observations within finely defined occupations such as information security analyst is somewhat limited. Consequently, we use the information on workers in other IT occupations to provide additional information and context.²⁵

From this data set, we can determine the total number of people employed in these occupations, as well as their earnings and education. We look at all full-time workers, but since our analysis is focused on the enlisted force, we also examine a representative set of civilian workers who mirror our population. This "comparable" worker is between 20 and 34 years old and has at least a high school diploma but no (four-year) college degree.

Figure 6 illustrates the number of people employed in each IT occupation; note that the numbers are weighted to be representative of the U.S. population. Over 3.3 million people are employed across these occupations. The size of these IT occupations varies considerably, and information security analysts make up a small part of our sample, but we still have sufficient data on this occupation to estimate earnings.

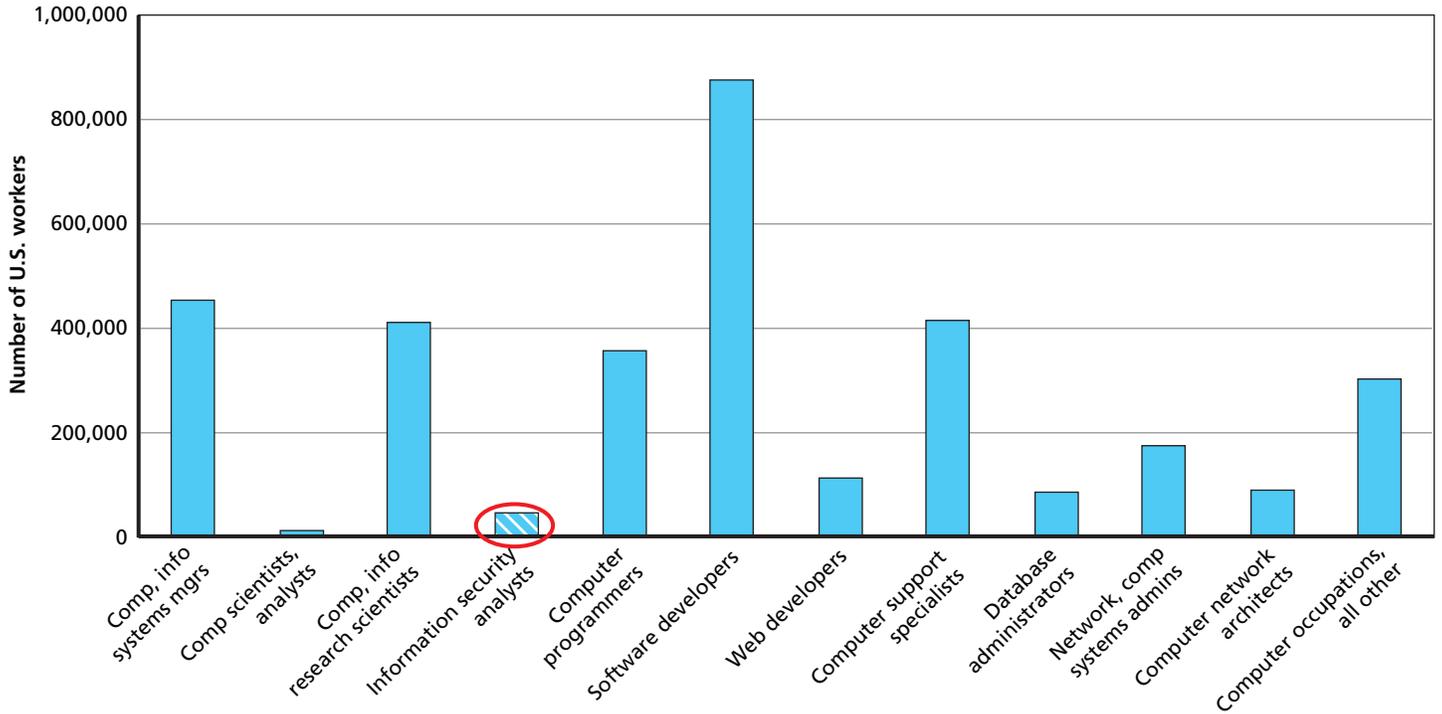
In Figure 7, we compare the median annual earnings for full-time U.S. workers with those of the IT occupations listed in Figure 6. Figure 7 illustrates that those employed in IT occupations have relatively higher earnings; the median earnings for all workers in our sample is about \$42,600, but those in IT occupations have median earnings of \$82,300 per year.²⁶ However, there is considerable variation in earnings across IT occupations, with those working as information security analysts earning higher pay than those working in many other IT occupations.

While median earnings are informative, there is substantial variation in earnings even *within* each of these occupations. Consequently, we examine the range in earnings among those working full time in IT and, in particular, for those working as information security analysts. We also examine earnings of "comparable" workers to our enlisted force (aged 20 to 34 years and high school graduates without four-year college degrees), as the jobs held by this group likely represent the jobs available to soldiers who wish to transition to the civilian world.

Figure 8 shows the median earnings, as well as earnings at the 25th and 75th percentile, for several groups. The left half of the graph includes earnings of all those employed full time, as well as earnings of all IT workers and all information security analysts. The variation between groups shown in Figure 7 is still evident, but there is also substantial variation within a single group. The right half of Figure 8 presents similar information—earnings of all workers, all IT workers, and all who work as information security analysts—but in this case, we include only our "comparable" workers.²⁷ Among this younger group without four-year college degrees, overall earnings are lower, and variation within each group is lower as well. However, substantial variation still exists.

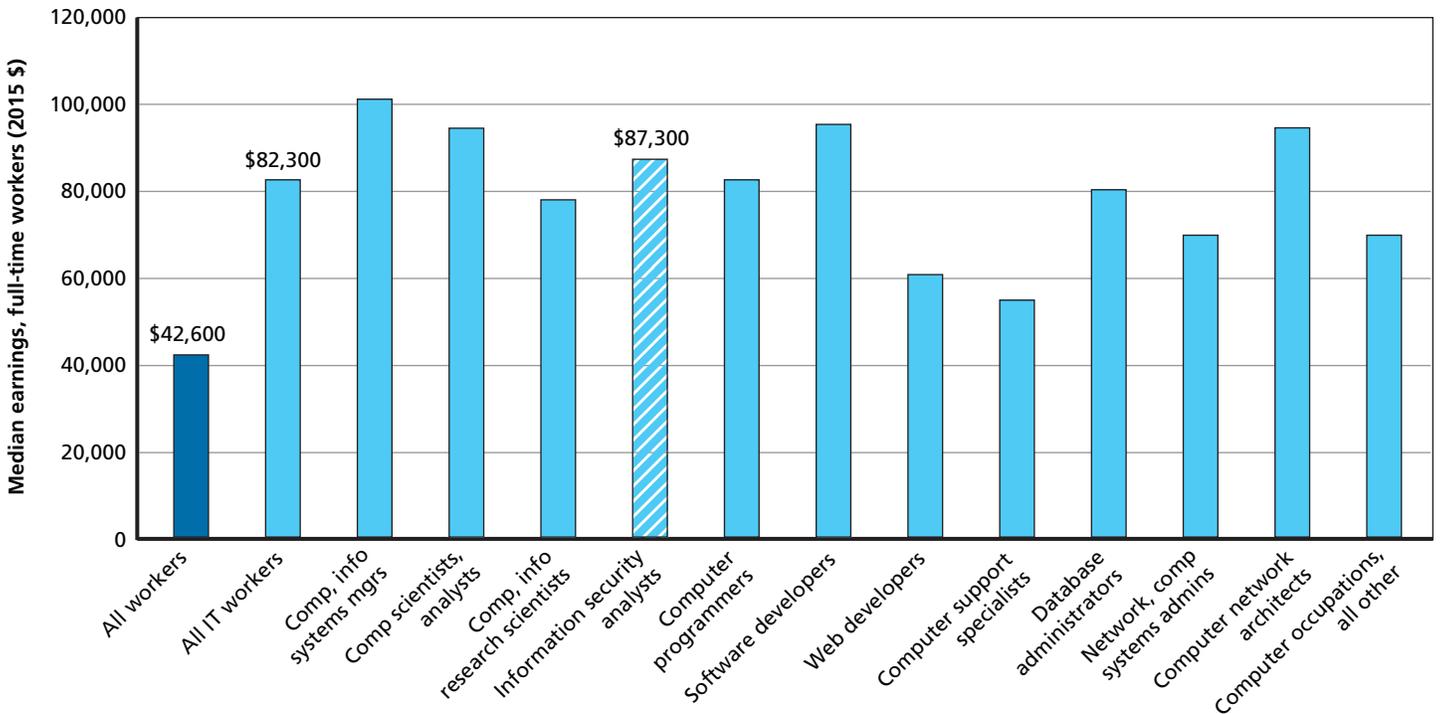
Once a soldier completes his or her initial obligation, that soldier is likely to compare their Army pay and other compensation with the wages available in the civilian sector. Figure 9 shows the range of median earnings for all IT workers and just InfoSec analysts for various characteristics and compares those earnings with military pay. Military pay, calculated for personnel near the end of a first term, appears on the far right.²⁸ It is

Figure 6. Over 3 Million People Are Employed Across IT Occupations, and the Size of the Occupations Varies Considerably



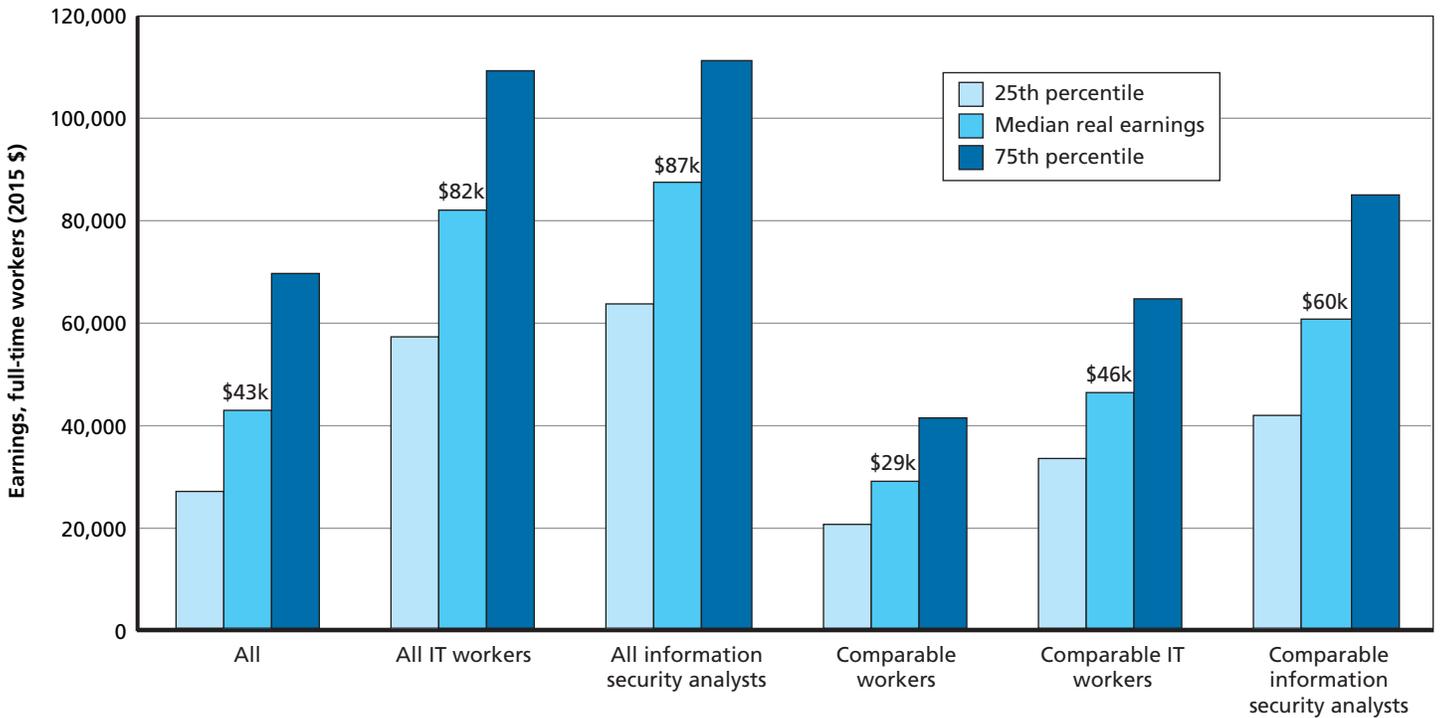
SOURCE: RAND Arroyo Center analysis of ACS data.
NOTE: "Comp" = computer.

Figure 7. Those in IT Occupations Have Relatively Higher Annual Earnings Than Other Workers



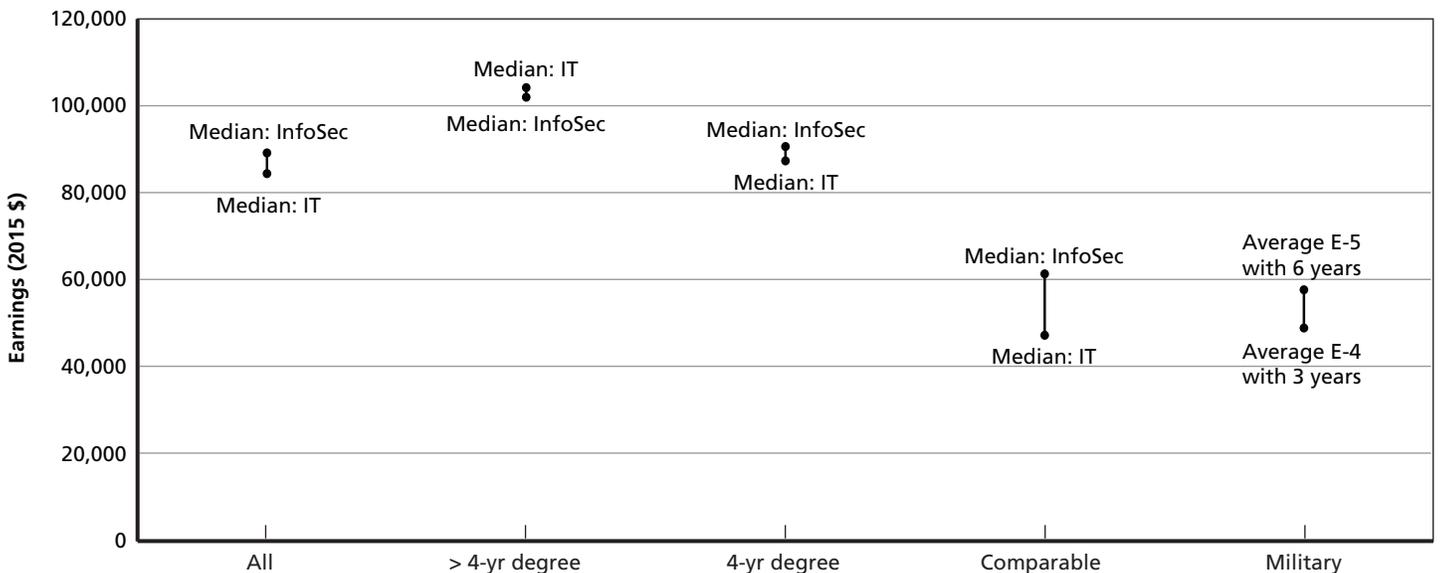
SOURCE: RAND Arroyo Center analysis of ACS data.

Figure 8. Annual Earnings Vary Substantially Within IT-Related Occupations



SOURCE: RAND Arroyo Center analysis of ACS data.

Figure 9. Military Pay Falls Between the Median Pay for Comparable IT Workers and the Median Pay for Comparable InfoSec Workers



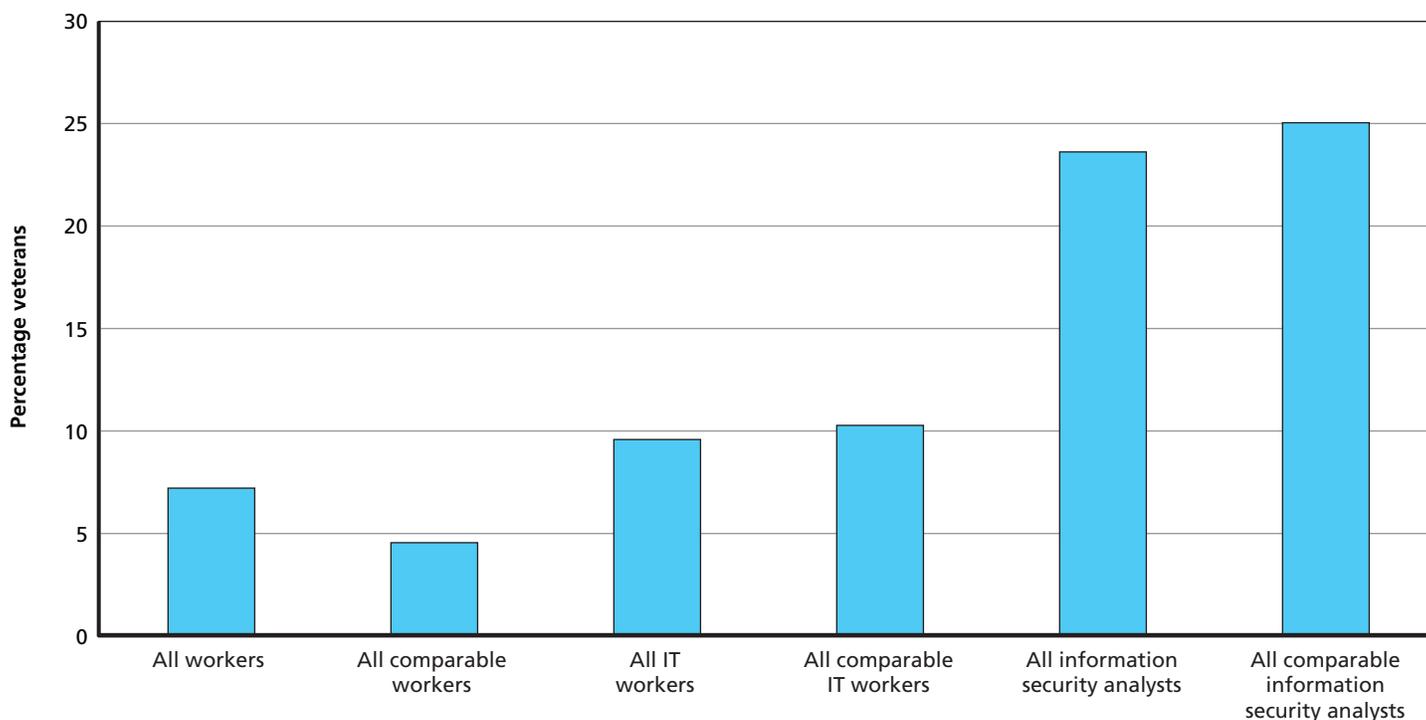
SOURCE: RAND Arroyo Center analysis of ACS data and Regular Military Calculator (see Department of Defense, "Regular Military Compensation (RMC) Calculator," online tool, undated).
 NOTE: Military pay averaged between Ft. Meade and Ft. Gordon (primary locations for 17C soldiers) and includes pay, basic allowance for housing and subsistence, and tax advantages. The estimate is considered conservative, since it assumes single status and excludes benefits such as special pay, reenlistment bonuses, and health benefits.

interesting to note that military pay falls between the median pay for comparable IT workers and the median pay for comparable InfoSec workers (recall that the comparable groups include young workers without a four-year college degree). This suggests that military compensation is generally comparable to the median earnings of the most relevant groups. Of course, the previous figures indicate that there is quite a bit of variation within each of these groups (occupational pay tends to vary less in the Army than in the civilian sector). Partly due to this variation, special pays may be required to improve reenlistment rates, but Army pay compares somewhat favorably with median civilian pay. The lefthand side of the figure, however, indicates that pay for all workers in the IT and InfoSec fields is considerably higher than Army compensation. Some of the difference is due to experience levels, while some is due to education. We break out civilian pay by education level in this figure as well; it is not surprising that those with advanced degrees have higher earnings. About 68 percent of those employed in IT occupations and about 63 percent of those employed in InfoSec jobs have a four-year or postgraduate degree. While opportunities certainly exist in these fields for workers who lack a four-year college degree, there is a strong relationship between education and pay. This suggests that Army compensation may be relatively comparable to the civilian compensation enlisted per-

sonnel would receive in many cases.²⁹ However, enlisted cyber soldiers with a four-year college degree are likely to see a larger pay discrepancy between the Army and the civilian sector. For reference, slightly less than 20 percent of soldiers in 35Q have a four-year college degree, whereas among all Army enlisted accessions, less than 10 percent have a four-year college degree.

Finally, we note that we do not have specific information on the experiences of soldiers in 35Q who transition to civilian employment and, of course, no soldiers from 17C have yet transitioned to civilian employment. It may be the case that a substantial number of soldiers who serve in cyber-related MOSs decide to work in other areas after leaving the Army. However, we do know which workers in our ACS sample are veterans. As shown in Figure 10, about 7 percent of full-time workers are veterans, and the proportion is lower among our comparable group (i.e., among young workers with less than a four-year college degree, just under 5 percent are veterans). IT workers are somewhat more likely than others to be veterans, but InfoSec analysts are far more likely than other workers to be veterans, and about one-quarter of comparable InfoSec workers are veterans. While we still lack information about the transition of soldiers from key MOSs into the civilian sector, this figure suggests that jobs within the information security analyst occupation are attractive to, and obtainable by, some veterans.

Figure 10. IT Workers Are Somewhat More Likely Than Other Workers to Be Veterans; InfoSec Analysts Are Far More Likely to Be Veterans



SOURCE: RAND Arroyo Center analysis of ACS data.

We also examined information on the sector in which each person worked; those employed as information security analysts are far more likely than others to report that they work for the federal government.³⁰

Although information security analyst jobs make up a small fraction of all IT jobs, the demand for information security analysts keeps increasing. The Bureau of Labor Statistics predicts that information security analyst jobs will grow 18 percent between 2014 and 2024, whereas IT jobs, in general, will grow only 12 percent.³¹ Consistent with this, industry publications have begun to report a sharp increase in information security-related job postings and an increase in the time to fill these jobs.³² This suggests that in the future, InfoSec-related jobs will make up a larger fraction of IT jobs; under such conditions, civilian wages would also be expected to increase.

When comparing Army and civilian options, soldiers may consider factors beyond current pay. Examples of such factors include the probability of unemployment and expected future wage growth. The probability of unemployment in the civilian sector is, of course, higher than in the military, but the perceived probability of unemployment in the InfoSec field is likely to be small due to the expected growth in the industry. Expectations of wage growth over time are likely to be based on the extent to which earnings differ with experience. In the Army, the relationship between pay and experience is fairly straightforward, as basic pay is defined by rank and years of service. In the civilian sector, the relationship is less straightforward. However, the ACS data include the information needed to estimate wage growth; when we estimate a straightforward wage equation, we find that the returns to experience are roughly 7 percent per year over the first ten years of a career for InfoSec analysts. In the next ten years, returns to experience are lower.³³

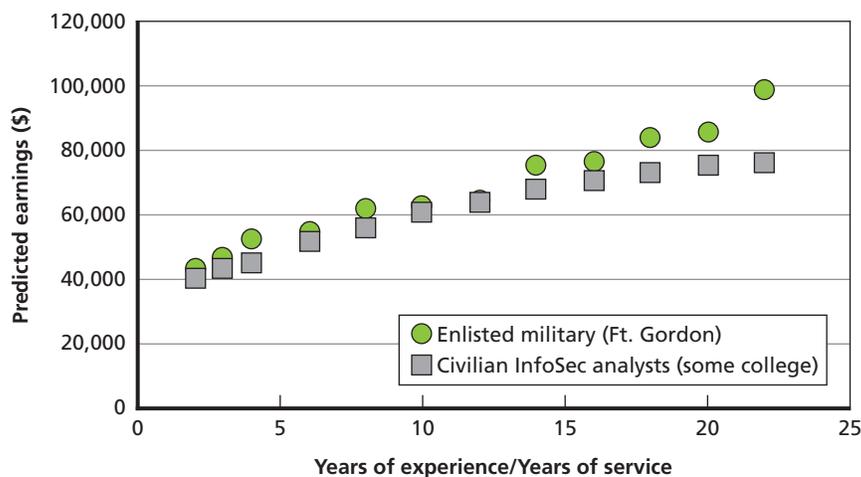
Figure 11 illustrates the expected wage growth for InfoSec analysts in the civilian sector with some college and, for comparison, the basic level of compensation for a reasonable career trajectory in the enlisted forces. By focusing on civilians with some college, we are equating the Army’s cyber training to what might be received by a civilian who has attended college but has not completed a four-year degree. The military compensation was determined using the RMC calculator for a soldier without depen-

dents located at Ft. Gordon, with a single filing tax status. The military pay includes basic pay, basic allowance for housing and subsistence, and tax advantages, but it *excludes* other aspects of total compensation such as special duty assignment pay, reenlistment bonuses, and health benefits. As a result, this produces a very conservative estimate likely to underestimate the earnings of the soldiers in the 17C MOS. As the graph shows, military pay tends to be competitive with civilian pay for InfoSec analysts who have only some college, for comparable levels of experience. The pay tends to diverge toward the more experienced end of the spectrum, but given the relative “newness” of the InfoSec analyst career field, it is likely unwise to put too much emphasis on those differences.

Concluding Observations

The likely civilian occupation that has substantial overlap with the job duties and qualifications of those in the 17C MOS is information security analyst. The relatively high rate of veterans in that particular civilian occupation is consistent with what we might expect to find if this occupation is attractive to former military personnel. Of course, we note that these veterans do not represent soldiers who served in the brand new Cyber 17C MOS. Moreover, we do not have any additional information about the previous military occupations of veterans in these jobs. Therefore, the relatively high rate of veterans working as InfoSec analysts should be considered suggestive, rather than definitive, evidence.

Figure 11. Military Pay Tends to Be Competitive with Civilian Pay for InfoSec Analysts Who Have Only Some College



SOURCE: RAND Arroyo Center analysis of ACS data and RMC.

Although InfoSec analysts have higher wages than many other occupations, the median pay for young InfoSec workers without a four-year college degree is comparable to the military pay of soldiers near the end of a first term. However, the data indicate that the median pay for InfoSec workers with a college degree is considerably higher than Army enlisted compensation.

Given that military pay for soldiers near the end of their first term is comparable to the median pay of likely jobs in the civilian sector, retention tools like SRBs and special pay can go a long way toward tipping the scales in favor of staying in the Army.

It is important to note that our analysis focused on the actual wages of InfoSec personnel, not the perceived wages. Retention efforts may be seriously hampered by the perceptions young enlisted might have regarding their civilian opportunities outside the Army.

CONCLUSIONS AND IMPLICATIONS

The Army's new cyber operations specialist MOS, 17C, has stringent entrance criteria; in particular, the required scores on the ST and GT line scores mean that only a fraction of new enlistees are qualified to enter the MOS. However, the number likely qualified far exceeds the likely requirement. Even at somewhat higher line score requirements, this would remain the case.

Of course, continuation rates are strongly associated with first-term obligation length. However, early-term continuation (or attrition) rates are also associated with other characteristics. Across our sample, more than one-quarter of soldiers fail to complete at least 36 months of their contract for reasons classified as failure to adapt. Attrition is a key metric for the Army due to the costs associated with recruiting and training, but in occupations with long training pipelines, information about continuation past the first term could also be valuable. Our results indicate that soldiers likely to qualify for 17C are likely to have lower attrition rates than others.

The specialized training provided to Army cyber personnel is likely to be of value in the civilian world as well. In particular, InfoSec analysts command relatively high salaries, and a substantial proportion of civilian workers in this occupation are veterans. This suggests that a pathway exists for trained Army cyber personnel to enter the civilian work force. The InfoSec analyst field currently is quite small, but it is expected to grow substantially over the next decade. While the typical InfoSec analyst is

well paid, those who are more comparable to Army personnel (in terms of age and education) earn salaries that exceed Army compensation by relatively small sums. Thus, existing compensation tools may be used to manage this occupation.

Past research indicates that bonuses can be an important tool in managing technical occupations, but also that the existence of valuable training, as well as work conditions, can influence retention. Retaining trained personnel is not inexpensive; past research suggest that the cost of increasing retention with SRBs is likely to be as much as \$25,000 per man-year.³⁴ Indeed, retention is not always cost-effective; in some cases, the most cost-effective way to manage an occupation is to focus on enlisting and training sufficient personnel.³⁵

Recommendations for Managing Army Cyber Occupations

There are multiple tools available to manage a military occupational specialty; these include length of initial obligation, SRBs, and incentive or proficiency pays.³⁶

In the case of 17C, the long initial obligation is an important tool; past research indicates that new service members are not very sensitive to the initial contract length.³⁷ Additionally, many more new accessions likely qualify for the 17C MOS than are likely to be required, which indicates that the Army may have sufficient leverage to maintain its long initial obligation requirements, since there should be plenty of potential candidates willing to accept that condition.

An SRB is offered at the point of reenlistment (generally at the end of the first term, but SRBs can be authorized at later points as well). In the Army, each MOS that qualifies for an SRB is placed in a tier; payment amounts depend both on the tier and the additional obligation (a soldier in an MOS in a higher tier is eligible for a larger SRB; a soldier who reenlists for a longer period is also eligible for a larger SRB). SRBs authorized for 17C in FY 2016 ranged in value from about \$3,000 to about \$50,000. Depending on the specifics, a soldier working as a 17C could be eligible for bonuses across this range.³⁸

Finally, special or proficiency pay has been used for several types of jobs; examples include pilots and linguists. Such pays could require periodic checks of proficiency to ensure that the recipients maintain key skills; these special or proficiency pays constitute another potential retention tool for the 17C MOS.³⁹ Currently, the Army offers special duty assignment pay for some work roles in operational cyber units.

These tools have been shown to be cost-effective under a variety of circumstances, and can assist in meeting both enlist-

ment and retention goals.⁴⁰ Therefore, the combination of a long initial contract and valuable training is likely to result in significant man-years of productive effort. Coupling this with an SRB will allow substantial control over the manning of this MOS.

Accurately assessing the cost-effectiveness of retention tools requires collecting data on civilian opportunities, but also tracking enlistment and reenlistment rates. With detailed information, it is possible to modify existing models to determine the point at which additional retention tools are likely to become necessary; in particular, RAND's dynamic retention model can be modified to model compensation for a single MOS and can produce results that indicate when SRBs are likely to be needed.⁴¹

Under various scenarios, it is possible that the need for 17Cs would increase. If that were to occur, the information that we present in this report implies that the Army would most likely be able to fill additional training seats for 17C. However, should the MOS grow substantially, additional resources might be required to recruit and retain. In that case, a careful comparison of the 17C training curriculum with curricula provided outside the Army could reveal opportunities for recruiting those who have completed at least some of their training prior to enlistment.⁴² This could be a cost-effective strategy if the training overlap is substantial, and if it is possible to provide credit for training received outside the Army.

Finally, the existing research strongly suggests that tracking civilian compensation and hiring will play an important role in managing Army cyber occupations; if civilian compensation or the value of Army-provided training or soldiers' experiences in Army cyber occupations change, then adjustments may be required to manage these occupations in the most effective manner possible.

In summary, managing this small, new occupation will require attention. Given the current civilian pay available, existing tools likely can be used to effectively manage 17C. However, ongoing analyses should include careful tracking of successful training completion and retention rates, as well as civilian pay and demand for information security analysts in the civilian sector. This information will play an important role in managing this occupation.

APPENDIX A. PERSONNEL DATABASE DESCRIPTIONS

Total Army Personnel Database

Because different files contain differing information and variables, our analytical file is derived from several administrative files. We use variables from the Army's Total Army Personnel Database (TAPDB) and Regular Army (RA) Analyst files, as well as test scores from Defense Manpower Data Center's Military Entrance Processing Command file. We formed our data set by selecting on non-prior service accessions who enlisted in the regular Army in the period FY 2001 to FY 2015. We excluded a small number of observations missing data for key variables—Armed Forces Qualification Test (AFQT) or ASVAB scores, or citizenship indicators. This decreased the size of the sample by less than 1 percent.

After these exclusions, we had more than 1 million observations on non-prior service enlisted Army accessions during this time period. We formed measures of continuation and attrition; while related, these indicators measure somewhat different aspects of service. Continuation is defined as remaining in the enlisted regular Army; attrition is defined as leaving prior to the end of one's initial obligation for reasons classified as *failure to adapt* (thus, personnel who leave due to injury or who become officers are not considered attrites, but neither are they counted as continuing).⁴³ We formed measures of waivers likely to be related to a soldier's ability to hold a security clearance; we included information on both Delayed Entry Program and accession waivers linked to drug use, alcohol use, or *moral* issues (moral issues include serious traffic violations as well as felonies).

American Community Survey

The ACS is a yearly survey designed to supplement the U.S. Census. The 1-percent sample includes approximately 3.1 million observations per year. We used the most recent sample available; this sample includes information from 2010 to 2014. We used the weights provided to produce a sample representative of the U.S. population.⁴⁴

We defined IT workers to include the following occupations: computer and information research scientists, computer systems analysts, information security analysts, computer programmers, software developers or applications and sys-

tems, web developers, computer support specialists, database administrators, computer network architects, and all other computer occupations. We recognize that this group includes substantial variation in terms of job duties, education levels, and pay; for this reason, we present many of our results by occupation. We focused on information security analysts as the occupation that most closely matches the training and experience of those in the 17C MOS. We included those who work at least 35 hours a week and have positive earnings. We inflated all earnings to 2015 dollars using the Consumer Price Index.⁴⁵

We experimented with focusing on males, as the majority of soldiers are male, and civilian earnings differ substantially between men and women. However, the majority of IT workers, and the vast majority of InfoSec analysts, are men; also, differences between men and women are smaller for this group. Thus, limiting the sample to men produces a somewhat smaller sample but otherwise changes the results in only a minor fashion.

APPENDIX B. REGRESSION RESULTS

Table 2 includes complete regression results from the regressions discussed in the section on retentions. In these regressions, we model continuation as a function of soldier characteristics (gender, age at entry, and AFQT score), length of initial contract, fiscal year of accession, and an indicator of qualification for 17C. Across the sample, about one-quarter of new accessions qualify for 17C.

The regressions are logistic (logit) regressions; this is the appropriate specification for a dichotomous outcome variable that takes on the value of either 0 or 1. In this case, continuation is defined as 1 for soldiers who continue in the Army, 0 otherwise. Thus, three-month continuation is defined as 1 for soldiers who continue in the Army for at least three months and 0 for those who have left the Army by three months; 72-month continuation is defined as 1 for soldiers who continue in the Army for at least 72 months and 0 for those who left the Army at any point prior to 72 months. The continuation *rate* is defined as the proportion of soldiers who remain in the Army; in our sample, continuation rates range from about 94 percent at three months to about 40 percent at 60 months.

Dependent variables in the equation are also coded as 0 or 1. The interpretation is straightforward in the case of

male and *qualified for 17C*; a value of 1 indicates that the soldier falls into these categories. In the case of *age at enlistment*, *length of initial obligation*, *fiscal year of enlistment*, and *AFQT score*, each soldier falls into one of the categories; in these cases, estimating the regression requires excluding one category. The excluded categories are *age 18 at enlistment*, *less than three-year obligation*, *enlisted in FY 2001*, and *AFQT score ≥ 93* . Therefore, the results indicate the level of difference between the estimated category and the excluded category. In Table 2, a star indicates statistical significance at the 95-percent level or better, implying that the result would occur by chance no more than 1 time in 20. In many cases, the probability of the result occurring by chance is much lower than 1 in 20.

These regression results indicate that qualifying for 17C is associated with increased levels of continuation. The size of the effect varies somewhat, but the marginal effect (the difference in continuation) generally implies that predicted continuation rates are 1 to 6 percentage points higher among those who qualify for 17C than among soldiers of the same age, AFQT score, length of obligation, and FY of enlistment who do not qualify for 17C.

Figure 4 in the text presents a representation of differences among 17C qualified soldiers and others; these differences (or *marginal effects*) are calculated holding constant other factors in the regression, such as age at enlistment and fiscal year of enlistment.⁴⁶ Focusing on the first 36 months, the period of time when failure to adapt attrition generally occurs, these results indicate that soldiers who qualify for 17C have attrition rates about 6 percentage points lower than those of otherwise similar soldiers who do not qualify for 17C. Given that about 25 percent of all soldiers leave the Army for failure to adapt reasons by 36 months, this difference is substantial.

Table 2. Regression Results: Continuation Models

Outcome Variable	3-Month Coeff	3-Month Std Error	12-Month Coeff	12-Month Std Error	36-Month Coeff	36-month Std Error	60-Month Coeff	60-Month Std Error
Qualified for 17C	0.142*	0.016	0.191*	0.010	0.307*	0.009	0.166*	0.009
Male	0.645*	0.010	0.663*	0.007	0.709*	0.007	0.480*	0.008
Age at enlistment								
Less than 18	0.111*	0.013	0.052*	0.009	0.021*	0.007	0.043*	0.008
21–24	0.012	0.011	0.070*	0.007	0.124*	0.006	0.127*	0.007
25-plus	-0.057*	0.013	0.055*	0.009	0.225*	0.008	0.307*	0.008
Length of initial obligation								
3 years	-0.098*	0.048	-0.193*	0.032	1.423*	0.023	0.398*	0.027
4 years	0.093*	0.048	0.009	0.032	1.606*	0.023	0.789*	0.027
5 years	0.022	0.049	-0.039	0.033	1.613*	0.025	1.725*	0.028
6 years	0.029	0.050	-0.028	0.033	1.595*	0.025	1.810*	0.028
AFQT Score								
AFQT 65–92	-0.372*	0.026	-0.216*	0.017	-0.212*	0.014	-0.006	0.013
AFQT 50–64	-0.475*	0.029	-0.255*	0.018	-0.252*	0.016	0.025	0.015
AFQT 31–49	-0.458*	0.029	-0.200*	0.019	-0.221*	0.016	0.185*	0.015
AFQT ≤ 30	-0.182*	0.047	-0.127*	0.029	-0.039	0.024	0.515*	0.023

Continued opposite

Notes

¹ Headquarters, U.S. Department of the Army, “Establishment of the United States Army Cyber Branch,” General Orders No. 2014-63, Washington, D.C., August 21, 2014.

² U.S. Joint Chiefs of Staff, *Cyberspace Operations*, Joint Publication 3-12 (R), Washington, D.C., February 5, 2013.

³ U.S. Army Human Resources Command, “Transition Strategy for Enlisted Personnel to MOS 17C,” MILPER Message Number 15-165, June 2, 2015b.

⁴ ASVAB includes standardized tests in nine separate areas (such as Paragraph Comprehension, General Science, and Mathematics Knowledge). The Army converts various combinations of these tests into composites or *line scores*. GT is an example of a line score; GT is formed from three ASVAB tests: Word Knowledge, Paragraph Comprehension, and Arithmetic Reasoning. Another pertinent line score is ST, which is formed from the following ASVAB tests: Mathematical Knowledge, Mechanical Comprehension, General Science, Paragraph Comprehension, and Word Knowledge. As such, GT and ST scores have some overlap; each also has some overlap with the Armed Forces Qualifying Test (AFQT) score. The AFQT score is used by all of the services; it is formed from four ASVAB tests: Arithmetic Reasoning, Mathematical Knowledge, Word Knowledge, and Paragraph Comprehension. Line scores are used to determine MOS qualification; different MOSs have different minimum line scores.

Table 2—Continued

Outcome Variable	3-Month Coeff	3-Month Std Error	12-Month Coeff	12-Month Std Error	36-Month Coeff	36-month Std Error	60-Month Coeff	60-Month Std Error
FY of enlistment								
2002	0.092*	0.022	0.118*	0.015	0.228*	0.013	0.114*	0.013
2003	0.132*	0.022	0.131*	0.015	0.297*	0.013	0.320*	0.013
2004	0.011	0.021	0.010	0.014	0.251*	0.012	0.379*	0.012
2005	0.356*	0.024	0.253*	0.016	0.387*	0.013	0.508*	0.013
2006	1.254*	0.030	0.601*	0.016	0.529*	0.013	0.505*	0.012
2007	0.854*	0.027	0.402*	0.016	0.431*	0.013	0.346*	0.013
2008	0.439*	0.024	0.379*	0.016	0.424*	0.013	0.159*	0.013
2009	0.442*	0.024	0.428*	0.016	0.493*	0.013	0.194*	0.013
2010	0.469*	0.024	0.588*	0.016	0.575*	0.013	0.314*	0.013
2011	0.574*	0.025	0.601*	0.017	0.554*	0.014	0.140*	0.028
2012	0.319*	0.024	0.470*	0.017	0.532*	0.014	—	—
2013	0.301*	0.023	0.477*	0.016	0.528*	0.032	—	—
2014	0.415*	0.025	0.516*	0.017	—	—	—	—
2015	0.419*	0.026	0.540*	0.042	—	—	—	—
Constant	2.292*	0.058	1.089*	0.038	-1.478	0.030	-2.090	0.033

NOTE: Outcome is continuation at each time period; columns list coefficients, standard errors. Analyses based on TAPDB and RA Analysis databases; sample includes enlisted accessions FY 2001–FY 2015. Excluded categories: female; age 18 at enlistment; AFQT score \geq 93; enlisted in FY 2001; less than three-year obligation. We experimented with alternate specifications and sample definitions—for example, including quarter of enlistment and excluding the shortest initial obligations. Results were generally insensitive to these changes.

* Indicates coefficient is significant at the 5-percent level or better, indicating result is unlikely to have occurred by chance. Models of 24-, 48-, and 72-month continuation are excluded for brevity, but results are consistent with those shown here; at each point in time, overall predicted continuation is higher for those who are 17C qualified. No FY 2014–2015 enlistments included in 36-month continuation because our data set includes less than 36 months of information on this group; no FY 2012–2015 enlistment included in 60-month regression for same reason.

⁵ U.S. Army Human Resources Command, “Regular Army Reclassification Procedures for MOS 17C (cyber operations specialist),” MILPER Message Number 15-164, June 2, 2015a.

⁶ Not all requirements are listed. For example, although new accessions to 17C require a minimum score on the Cyber test (CT) (formerly the ICTL test), we do not include that requirement for our comparison group, since relatively few personnel have completed the test. Additionally, 35P (Cryptologic Linguist) requires a minimum score on the DLAB, but again, not all soldiers take that test.

⁷ For more information about our analytical file and the databases used to form the file, see Appendix A.

⁸ Key waivers include waivers for drug use, alcohol use, and significant legal issues such as serious traffic violations and felonies. Many of the issues that result in such waivers would likely prevent a soldier from holding a clearance. Little information is available on the reasons why clearance is not granted to soldiers. There is some information available for civilians who objected to an initial negative finding; in such cases, financial considerations are prominent (William Henderson, “DOHA: Top Reasons for Security Clearance Denial in 2008,” ClearanceJobs.com, January 10, 2009). A study reviewing the results of periodic reinvestigations for those holding a Single Scope Background Investigation (SSBI) included some reinvestigations for DoD personnel; this study also found that financial issues (rather than security issues) were predominant among issues raised during investigations. See Lisa A. Kramer, Kent S. Crawford, Richards J. Heuer, Jr., and Robert R. Hagen, *SSBI-PR Source Yield: An Examination of Sources Contacted During the SSBI-PR*, Monterey,

Calif.: Defense Personnel Security Research Center, Technical Report 01-5, August 2001. Given their ages, new soldiers may be less likely than others to have financial issues that prevent them from obtaining a clearance. More recent studies have tended to focus on detecting individuals who could carry out terrorist acts (rather than simply screening out those who should not hold a clearance); for example, one study focusing on military personnel indicated a total of 131 cases (out of roughly 1.5 million) in which subjects were found to have some association or sympathy with an extremist group; see Kelly R. Buck, Andree E. Rose, Martin F. Wiskoff, and Kahlila M. Liverpool, *Screening for Potential Terrorists in the Enlisted Military Accessions Process*, Monterey, Calif.: Defense Personnel Security Research Center, Technical Report 05-8, April 2005. Taken together, the information suggests that the large majority of new enlistees are likely to be eligible to hold a security clearance. Therefore, while our estimates are likely overestimates of the total proportion eligible to enlist in these MOSs, the overestimate appears modest in size.

⁹ The pairwise correlation between ST and GT scores is 0.906. This high correlation is not surprising, as two different ASVAB subtests (Word Knowledge and Paragraph Comprehension) are used when forming both line scores; each includes a mathematics-related subtest as well. The ST score includes the Math Knowledge subtest, and the GT score includes the Arithmetic Reasoning subtest; these two subtests are also highly correlated.

¹⁰ On first-term performance, see (among many others) Richard J. Buddin, *Success of First-Term Soldiers: The Effects of Recruiting Practices and Recruit Characteristics*, Santa Monica, Calif.: RAND Corporation, MG-262-A, 2005. For costs, see Deputy Assistant Secretary of the Army for Cost and Economics (DASA-CE), “Cost Management: Resource Informed Decision Making and Performance Management. Framework, Methodology, Cost of Recruiting & IMT – Case Study,” PowerPoint presentation provided to RAND by DASA-CE, October 2015.

¹¹ Therefore, soldiers who complete their terms of service, become officers, or who leave the Army due to injury or die while in the Army are not considered to have attrited. Failure to adapt attrition has at times been referred to as attrition for *adverse reasons*. In these cases, separation codes most often indicate that the soldier left the Army due to a failure to meet performance or behavioral standards. Note that a substantial proportion of soldiers become officers or join the reserve component during their first term, or leave the Army due to injury or disability, or die while in the Army; across the period covered by our sample, this makes up about 10 percent of all separations. We do not consider these separations to constitute attrition; however, soldiers who leave the enlisted Army for these reasons are not counted as part of our continuation rates either. There is an argument to be made that soldiers who become officers should be counted as continuing in the Army. Altering our calculations to count these soldiers as continuing makes very little difference in terms of our results.

¹² See, among others: Buddin, 2005; Jennie W. Wenger, and Apriel K. Hodari, *Predictors of Attrition: Attitudes, Behaviors and Educational Characteristics*, Alexandria, Va.: Center for Naval Analyses, CRM D0010146.A2, July 2004; Janice H. Laurence, Peter F. Ramsberger, and Jane Arabian, *Education Credential Tier Evaluation*, Human Resources Research Organization, FR0EADD-96-19, September 1996; Rebecca M. Kilburn and Beth J. Asch, *Recruiting Youth in the College Market*, Santa Monica, Calif.: RAND Corporation, MR-1093-OSD, 2003; Aline O. Quester, *Marine Corps Recruits: A Historical Look at Accessions and Bootcamp Performance*, Center for Naval Analyses, CAB D002537.A1.s, September 2010.

¹³ Amanda Kraus and Jennie Wenger, “College Recruits in the Enlisted Navy: Navy Outcomes and Civilian Opportunities,” Alexandria, Va.: Center for Naval Analyses, D0010405.A2, September 2004.

¹⁴ These statistics mix attrition and retention; soldiers who depart prior to 24 months generally have attrited, as none had obligations of less than 24 months, but soldiers who depart at 48 months often have completed their initial obligations, and those who depart at 72 months have almost always completed the initial obligation. Also note that the continuation rate at each point in time measures the proportion of soldiers who remain in the Army at that point; therefore a continuation rate of 45 percent means that 45 percent of the original cohort remains in the Army.

¹⁵ Internal and external conditions differ between 17C and the MOSs in which these soldiers currently serve; thus, the behavior of these soldiers is not likely to reflect exactly that of 17Cs. However, these soldiers possess individual characteristics likely to be similar to those of soldiers in 17C. As the research of Buddin, 2005, among others has shown, individual characteristics are highly predictive of first-term attrition rates.

¹⁶ Jennie W. Wenger, Bruce R. Orvis, David M. Stebbins, Eric Apaydin, and James Syme, *Strengthening Prior Service-Civil Life Gains and Continuum of Service Accessions into the Army's Reserve Components*, Santa Monica, Calif.: RAND Corporation, RR-1376-A, 2016.

¹⁷ Regressions estimate the probability of continuation at each point shown in Figure 4. These logistic (logit) models include fiscal year of enlistment, gender, AFQT score category, as well as indicators of initial obligation length, and of age at enlistment. The outcome variable is continuation, defined at each point in time as a value of 1 for those who remain in the Army and 0 for those who do not. The results indicate that even when we hold constant these other factors, soldiers who meet the enlistment standards for 17C have continuation rates higher than those of other soldiers. The differences are statistically significant (very unlikely to have occurred by chance). See Appendix B for regression results through 60 months; results beyond 60 months are excluded for brevity but are qualitatively similar.

¹⁸ DASA-CE, 2015.

¹⁹ Note that we do not model reenlistment explicitly, but a difference in reenlistment rates at the end of the first term is consistent with our findings in terms of continuation.

²⁰ Military applicants do not appear to be dissuaded from enlistment by long initial contracts; see Jared M. Huff, Yevgeniya K. Pinelis, and Jennie W. Wenger, *Adjusting First-Term Contract Lengths in the Navy: Implications and Recommendations*, Alexandria, Va.: Center for Naval Analyses, Research Report DRM-2013-U-004794, 2013.

²¹ James R. Hosek, Michael G. Mattock, C. Christine Fair, Jennifer Kavanagh, Jennifer Sharp, and Mark Totten, *Can the Military Successfully Meet the Demand for Information Technology Personnel?* Santa Monica, Calif.: RAND Corporation, RB-7568-OSD, 2004. For an analysis of manning levels and reenlistment rates in technical Navy jobs, see Michael L. Hansen, *Compensation and Enlisted Manning Shortfalls*, Alexandria, Va.: Center for Naval Analyses, CRM D0001998.A2, 2000.

²² Hosek et al., 2004. We discuss the role of bonuses in managing retention in the next section.

²³ Lara Schmidt, Caolionn O’Connell, Hirokazu Miyake, Akhil R. Shah, Joshua Baron, Geof Nieboer, Rose Jourdan, David Senty, Zev Winkelman, Louise Taggart, Susanne Sondergaard, and Neil Robinson, *Cyber Practices: What Can the U.S. Air Force Learn from the Commercial Sector?* Santa Monica, Calif.: RAND Corporation, RR-847-AF, 2015.

²⁴ U.S. Bureau of Labor Statistics, *Occupational Outlook Handbook*, December 17, 2015.

²⁵ For a detailed list of the occupations defined as IT and additional information about our ACS sample, see Appendix A.

²⁶ Note that Figure 7 reports median annual earnings; there are no adjustments for level of education, actual hours worked (which varies even among full-time workers), or regional differences. All of these factors are likely to influence earnings. However, our purpose here is not to determine the sources of wage differences, but rather to document the earnings available in the civilian sector. In other words, we are interested in the earnings that soldiers might observe in the civilian sector.

²⁷ Although Figure 8 does not include notes of the size of each sample, the comparable information security analysts actually make up 35 percent of all information security analysts. Thus, over one-third of InfoSec analysts employed in the civilian sector lack a four-year college degree. This suggests that civilian employers are willing to hire those without college degrees for InfoSec jobs. (The proportion of comparable InfoSec workers without college degrees is higher than the proportion of all comparable IT workers without college degrees.)

²⁸ Military pay includes basic pay, basic allowances for housing and subsistence, and the tax advantage. This estimate is considered conservative, as it assumes single status and excludes health benefits as well as special pays and reenlistment bonuses.

²⁹ This is consistent with the findings of Schmidt et al., 2015.

³⁰ Seventeen percent of information security analysts and 18 percent of comparable information security analysts work for the federal government; in contrast, about 4 percent of all full-time workers are employed by the federal government.

³¹ U.S. Bureau of Labor Statistics, “Computer and Information Technology Occupations,” in *Occupational Outlook Handbook*, Washington, D.C., January 8, 2014.

³² Burning Glass Technologies, *Job Market Intelligence: Cybersecurity Jobs, 2015*, 2015.

³³ We obtain this estimate from a regression explaining the log of inflation-adjusted wages; we include indicators of gender, level of education, year, and experience. The ACS does not include a precise measure of experience; we form a proxy measure based on age and years of education, as is common in the literature. We include this measure of experience, as well as squared, cubic, and quartic terms as suggested by Kevin M. Murphy and Finis Welch, “Empirical Age-Earnings Profiles” *Journal of Labor Economics*, Vol. 8, No. 2, 1990, pp. 202–229. We estimate this model for full-time InfoSec analysts, and for full-time IT workers with controls for each occupation. In each case, the results indicate that wages of workers in the first decade of their careers show an average growth of about 7 percent per year, and that the yearly wage growth is lower after the first decade.

³⁴ Beth J. Asch, *Cash Incentives and Military Enlistment, Attrition, and Reenlistment*, Santa Monica, Calif.: RAND Corporation, MG-950-OSD, 2010. The estimates in this document are dependent on data from FY 1998 to FY 2008 and are reported in 2008 dollars. Also note that the estimates are Army-specific but include a range of MOSs.

³⁵ Chaitra M. Hardison, Michael G. Mattock, and Maria C. Lytell, *Incentive Pay for Remotely Piloted Aircraft Career Fields*, Santa Monica, Calif.: RAND Corporation, MG-1174-AF, 2012.

³⁶ Other tools exist; in particular, basic pay is a retention tool. However, the design of the pay table means that basic pay is a blunt tool—pay raises are carried out across the board, affecting all personnel regardless of MOS or length of service. Especially in the case of such a small MOS, across-the-board pay raises are not well suited for managing retention; more focused tools, such as MOS-specific bonuses, have the potential to manage individual MOSs in a more targeted (and thus more efficient) manner.

³⁷ Huff, Pinelis, and Wenger, 2013.

³⁸ DoD Human Resources Command, “Selective Reenlistment Bonus (SRB),” MILPER Message Number: 16-009, Washington, D.C., January 12, 2016.

³⁹ There are many types of special and incentive pays; the Services utilize these in a variety of ways. See Beth J. Asch, James Hosek, and Craig Martin, *A Look at Cash Compensation for Active-Duty Military Personnel*, Santa Monica, Calif.: RAND Corporation, MR-1492-OSD, 2002.

⁴⁰ Asch, 2010. This work also suggests that recruiters may be a more cost-effective tool than enlistment bonuses for increasing enlistment; we do not explicitly discuss recruiters here because it is unlikely that the Army will decide to change the number of recruiters based on cyber occupations alone.

⁴¹ Hardison, Mattock, and Lytell, 2012, present results from applying the dynamic retention model to remotely piloted aircraft occupations.

⁴² Examples of curricula provided outside the Army could include those available from two-year and four-year educational institutions such as the Centers of Academic Excellence in Cyber Defense, which are designated by the National Security Agency and the Department of Homeland Security, as well as certificate programs such as those offered by organizations such as SANS Technology Institute and the International Information System Security Certification Consortium.

⁴³ Failure to adapt attrition can be thought of as occurring when soldiers fail to meet performance or behavioral standards. We include those who will eventually leave the enlisted Army due to injury or to become officers in our counts of initial enlistees and our calculations of the proportion qualified for key MOSs. But we consider them as non-attrites in the attrition calculations, and we exclude them completely when calculating the proportion of soldiers that continue in the (enlisted) Army.

⁴⁴ We thank our colleague Christine Peterson for her assistance in forming this data set. For more information, see U.S. Census Bureau, *American Community Survey (ACS)*, undated.

⁴⁵ U.S. Bureau of Labor Statistics, *Consumer Price Index*, undated.

⁴⁶ Because logit regressions are nonlinear in nature, the interpretation of the coefficients is not straightforward. To calculate the marginal effects presented in Figure 4, we also carry out appropriate transformations on the coefficients in Table 2.

References

Asch, Beth J., *Cash Incentives and Military Enlistment, Attrition, and Reenlistment*, Santa Monica, Calif.: RAND Corporation, MG-950-OSD, 2010. As of October 5, 2016:
<http://www.rand.org/pubs/monographs/MG950.html>

Asch, Beth J., James Hosek, and Craig Martin, *A Look at Cash Compensation for Active-Duty Military Personnel*, Santa Monica, Calif.: RAND Corporation, MR-1492-OSD, 2002. As of October 5, 2016:
http://www.rand.org/pubs/monograph_reports/MR1492.html

Buck, Kelly R., Andree E. Rose, Martin F. Wiskoff, and Kahlila M. Liverpool, *Screening for Potential Terrorists in the Enlisted Military Accessions Process*, Monterey, Calif.: Defense Personnel Security Research Center, Technical Report 05-8, April 2005.

Buddin, Richard J., *Success of First-Term Soldiers: The Effects of Recruiting Practices and Recruit Characteristics*, Santa Monica, Calif.: RAND Corporation, MG-262-A, 2005. As of October 5, 2016:
<http://www.rand.org/pubs/monographs/MG262.html>

Burning Glass Technologies, *Job Market Intelligence: Cybersecurity Jobs, 2015*, 2015. As of May 23, 2017:
<http://burning-glass.com/research/cybersecurity/>

DASA-CE—See Deputy Assistant Secretary of the Army for Cost and Economics.

Department of Defense, “Regular Military Compensation (RMC) Calculator,” online tool, undated. As of May 18, 2017:
<http://militarypay.defense.gov/Calculators/RMC-Calculator/>

Deputy Assistant Secretary of the Army for Cost and Economics, “Cost Management: Resource Informed Decision Making and Performance Management Framework, Methodology, Cost of Recruiting & IMT- Case Study,” PowerPoint presentation provided to RAND by DASA-CE, October 2015.

Hansen, Michael L., *Compensation and Enlisted Manning Shortfalls*, Alexandria, Va.: Center for Naval Analyses, CRM D0001998.A2, 2000.

Hardison, Chaitra M., Michael G. Mattock, and Maria C. Lytell, *Incentive Pay for Remotely Piloted Aircraft Career Fields*, Santa Monica, Calif.: RAND Corporation, MG-1174-AF, 2012. As of October 5, 2016:
<http://www.rand.org/pubs/monographs/MG1174.html>

Headquarters, U.S. Department of the Army, “Establishment of the United States Army Cyber Branch,” General Orders No. 2014–63, Washington, D.C., August 21, 2014.

Henderson, William, “DOHA: Top Reasons for Security Clearance Denial in 2008,” ClearanceJobs.com, January 10, 2009. As of October 5, 2016:
<https://news.clearancejobs.com/2009/01/10/doha-top-reasons-for-security-clearance-denial-in-2008/>

Hosek, James R., Michael G. Mattock, C. Christine Fair, Jennifer Kavanagh, Jennifer Sharp, and Mark Totten, *Can the Military Successfully Meet the Demand for Information Technology Personnel?* Santa Monica, Calif.: RAND Corporation, RB-7568-OSD, 2004. As of October 5, 2016:
http://www.rand.org/pubs/research_briefs/RB7568.html

Huff, Jared M., Yevgeniya K. Pinelis, and Jennie W. Wenger, *Adjusting First-Term Contract Lengths in the Navy: Implications and Recommendations*, Alexandria, Va.: Center for Naval Analyses, Research Report DRM-2013-U-004794, 2013.

Kilburn, Rebecca M., and Beth J. Asch, *Recruiting Youth in the College Market*, Santa Monica, Calif.: RAND Corporation, MR-1093-OSD, 2003. As of October 5, 2016:
http://www.rand.org/pubs/monograph_reports/MR1093.html

Kraus, Amanda, and Jennie Wenger, *College Recruits in the Enlisted Navy: Navy Outcomes and Civilian Opportunities*, Alexandria, Va.: Center for Naval Analyses, D0010405.A2, September 2004.

Laurence, Janice H., Peter F. Ramsberger, and Jane Arabian, *Education Credential Tier Evaluation*, Human Resources Research Organization, FR0EADD-96-19, September 1996.

Qeuster, Aline O., *Marine Corps Recruits: A Historical Look at Accessions and Bootcamp Performance*, Alexandria, Va.: Center for Naval Analyses, CAB D002537.A1.s, September 2010.

Schmidt, Lara, Caolionn O’Connell, Hirokazu Miyake, Akhil R. Shah, Joshua Baron, Geof Nieboer, Rose Jourdan, David Senty, Zev Winkelman, Louise Taggart, Susanne Sondergaard, and Neil Robinson, *Cyber Practices: What Can the U.S. Air Force Learn from the Commercial Sector?* Santa Monica, Calif.: RAND Corporation, RR-847-AF, 2015. As of October 5, 2016:
http://www.rand.org/pubs/research_reports/RR847.html

U.S. Army Human Resources Command, “Regular Army Reclassification Procedures for MOS 17C (cyber operations specialist),” MILPER Message Number 15-164, June 2, 2015a.

———, “Transition Strategy for Enlisted Personnel to MOS 17C,” MILPER Message Number 15-165, June 2, 2015b.

U.S. Bureau of Labor Statistics, *Consumer Price Index*, undated. As of August 25, 2016:
<http://www.bls.gov/cpi>

———, “Computer and Information Technology Occupations,” in *Occupational Outlook Handbook*, Washington, D.C., January 8, 2014. As of October 5, 2016:
<http://www.bls.gov/ooh/computer-and-information-technology/home.htm>

———, *Occupational Outlook Handbook*, December 17, 2015. As of May 23, 2017:
<https://www.bls.gov/ooh/home.htm>

U.S. Census Bureau, *American Community Survey (ACS)*, undated. As of August 25, 2016:
<https://www.census.gov/programs-surveys/acs/>

U.S. Joint Chiefs of Staff, *Cyberspace Operations*, Joint Publication 3-12 (R), Washington, D.C., February 5, 2013.

Wenger, Jennie W., and Apriel K. Hodari, *Predictors of Attrition: Attitudes, Behaviors and Educational Characteristics*, Alexandria, Va.: Center for Naval Analyses, CRM D0010146.A2, July 2004.

Wenger, Jennie W., Bruce R. Orvis, David M. Stebbins, Eric Apaydin, and James Syme, *Strengthening Prior Service—Civil Life Gains and Continuum of Service Accessions into the Army’s Reserve Components*, Santa Monica, Calif.: RAND Corporation, RR-1376-A, 2016. As of October 5, 2016:
http://www.rand.org/pubs/research_reports/RR1376.html

About This Report

This document reports a subset of the results from a larger study examining the training and retaining of cyber operations specialists. In this document, we focus on providing information to assist the Army in managing the new 17C Cyber military occupational specialty (MOS). Because this MOS was created recently, there is little historical information available on the performance or retention of soldiers in the MOS. Instead, we describe our quantitative findings regarding the historical retention of recruits with similar qualifications as cyber operations specialists, as well as our findings on wage earnings available to these soldiers in the civilian sector. The findings should be of interest to those involved in planning, developing, and retaining a cyber workforce.

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