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Effect of Quality on the Attrition of Enlisted Marines from the Active Reserve

March 2023

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Naval Postgraduate School

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Prepared for the Naval Postgraduate School, Monterey, CA 93943.

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ABSTRACT

Marines who serve in the Active Reserve are vital to the success of the large reserve force. Though small in number, the Active Reserve provides critical support to the various components of the reserve force. Marine Reserve Affairs is concerned about the quality of Marines who access into the Active Reserve. The concern is that non-high quality accessions will have adverse impacts on the future Staff Non-commissioned Officer population. This research seeks to examine the attrition trends among Corporals and Sergeants using various measures of quality and different demographic categories. I conduct the research using 10 years of panel data provided by Marine Reserve Affairs. I use survival analysis to study the relationship between rank, quality, and attrition. I find that high-quality Corporals attrite at lower levels than high-quality Sergeants after meeting initial service obligations. This research could be used in the future to study why Marines in the Active Reserve attrite and which component of the larger reserve force they attrite into.



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LIST OF ACRONYMS AND ABBREVIATIONS

AC	Active Component
AFQT	Armed Forces Qualification Test
AR	Active Reserve
CFT	Combat Fitness Test
CSS	Combat Service Support
DOR	Date of Rank
ECFC	Enlisted Career Force Controls
FITREP	Fitness Report
GCT	General Classification Test
HQMC	Headquarters, Marine Corps
IRR	Individual Ready Reserve
IMA	Individual Mobilization Augmentee
MARADMIN	Marine Administrative Message
MCO	Marine Corps Order
MOS	Military Occupational Specialty
MCR	Marine Corps Reserve
NDAA	National Defense Authorization Act
PFT	Physical Fitness Test
PME	Professional Military Education
PMOS	Primary Military Occupational Specialty
RA	Reserve Affairs
RAM	Reserve Affairs Management
RV	Relative Value
RS	Reporting Senior
RC	Reserve Component
SelRes	Selected Reserve
SMCR	Selected Marine Corps Reserve
SNCO	Staff Non-commissioned Officer



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I. INTRODUCTION

A. BACKGROUND

The Active Reserve Guard (ARG) component of each military branch is codified in 10 U.S. Code and authorized each year in the National Defense Authorization Act (NDAA). The Marine Corps administers the Active Reserve program through Marine Corps Order 1001.52K (Headquarters, United States Marine Corps [HQMC], 2019).

Currently, enlisted Marines in the ranks of Corporals or Sergeants, access into the AR from the SMCR, IRR or AC. Marines wishing to join the AR must meet the requirements of the independent duty screening checklist. These Marines are often subject to Enlisted Career Force Controls (ECFC) such as date of rank adjustments. Further, the AR program allows for a certain number of Marines to lateral move into a new Military Occupational Specialty (MOS).

Reserve Affairs Management (RAM) branch manages the inventory of AR Marines. Based on conversations with personnel at RAM, quality of accessions is often viewed as low. Their measure of quality largely stems from the results of the independent duty screening checklist. These conversations indicate that RAM believes the non-high quality of current accessions will have future, negative effects in the Staff Non-commissioned Officer (SNCO) community.

This research seeks to determine if there is a relationship between quality and attrition and what effect that could have on the future AR SNCO population. Using measures of performance as proxies for quality, I analyze the link between quality, grade at accession, and length of service, and provide recommendations for policy to increase the quality among AR accessions.

B. RESEARCH QUESTION

Primary Question

1. What is the relationship between attrition from the AR and quality?



Secondary Questions

1. What is the length of service for Marines who access into the AR as Corporals?
2. What percentage of those Marines who attrite are Corporals, what percentage are Sergeants?

C. SCOPE

This thesis is a descriptive analysis of the quality of Corporals and Sergeants in the active reserve component through an examination of past performance, grade at accession, length of service, component accessing from and other career and demographic statistics. These variables are used primarily because they are of specific interest to RAM in assessing quality of AR accessions. These variables will help define one way to measure quality and help explain their role in the attrition of Marines from the active reserve.

D. METHODOLOGY

This study relies on panel data from the Total Force Data Warehouse (TFDW). TFDW is main repository for Marine Corps personnel data. The data were cleaned, merged, and analyzed using Stata which is a computer based statistical analysis software. Survival analysis is the primary econometric tool used to study attrition from the AR given someone's quality as defined by RAM. I relate time to attrition with several factors, focusing primarily on a Marine's quality. I define "high quality" as a Marine with mean PFT and CFT of at least 235, proficiency and conduct for grade of at least 4.5 for Corporals, and FITREP relative value at processing of at least 93.33 for Sergeants. These metrics are supported by prior literature as good measures of Marine quality. I conduct further analysis using descriptive statistics to show characteristics of the population such as length of service, quality, and rank at accession and attrition.

E. FINDINGS

I find that Corporals whom I define as high quality and who serve beyond their initial service obligation of 48 months have lower rates of attrition compared to all other Corporals who also serve beyond 48 months. High-quality Sergeants, however, leave at



higher rates than all other Sergeants, after meeting their initial 48-month service obligation. The indicator of high quality for Corporal and Sergeant are the only statistically significant predictor of attrition; however, Sergeants who have a personal award have a lower likelihood of attrition.

I also find that males tend have longer service times among both ranks but attrition is nearly identical by race up to approximately 50 months. I also find that Marines in a CSS MOS have longer service lengths than Marines in a combat arms or aviation MOS.

F. ORGANIZATION OF CHAPTERS

I organize my research into six chapters. Chapter II provides background information on the reserve component and specifically the active reserve. I also provide information about the AR accession process and how ECFCs impact Marines accessing into the AR. Chapter III reviews existing and relevant research that is applicable to my study. I describe the data and methodology in Chapter IV. Chapter V provides the results and findings of my analysis. Chapter VI summarizes my research and I provide recommendations to RAM and any recommendations for further studies.



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II. BACKGROUND

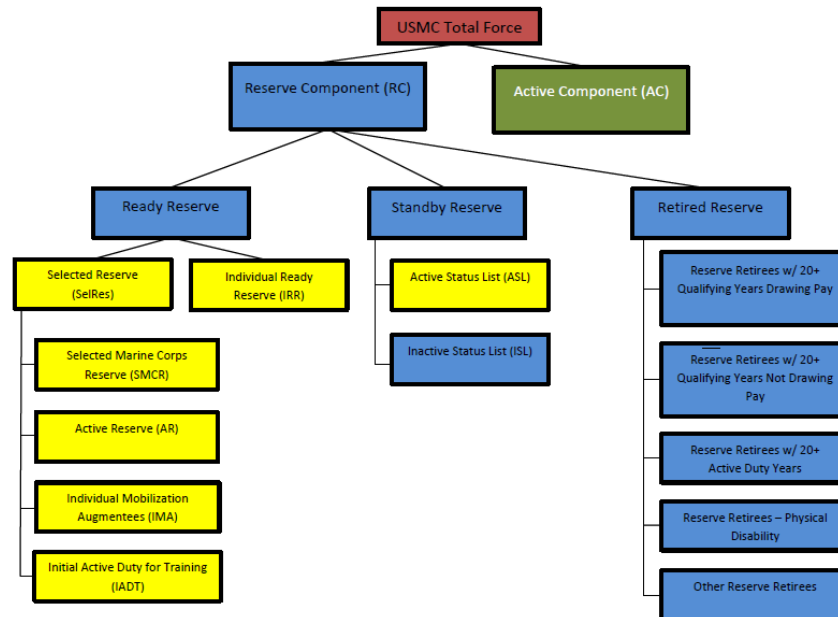
A. INTRODUCTION

The active reserve has unique service requirements not found among the broader reserve component or active-duty force. The nature and mission of the active reserve is either unknown or misunderstood by many in the Marine Corps. This chapter will describe the organization of the active reserve, its mission, and how Marines access into the AR.

B. ORGANIZATION OF THE MARINE CORPS RESERVE

The authorization for a reserve force lies in Title 10 U.S.C. Three reserve elements are authorized and include the Ready Reserve, the Standby Reserve, and the Retired Reserve (Armed Forces, 1956). Figure 1 depicts these three elements and the sub-elements contained within each.

Figure 1. Organization of the Marine Corps Reserve. Source: HQMC (2018).



As shown in Figure 1, the reserve component is part of the Total Force and according to HQMC MCO 1001R.1L (2018), is designed to “augment, reinforce, and sustain the Active Component” (p. 1-1). Reserve Component units under the ready reserve are manned by three of the four elements of the Selected Reserve (SelRes), the exception being Marines in an Initial Active Duty for Training status. These units mirror their active component counterparts in structure, capability, equipment, and training and are composed of AC, AC, and SMCR Marines. In the next section, I will look specifically at the AR component of the SelRes.

C. MISSION OF THE ACTIVE RESERVE COMPONENT

As part of the SelRes and broader Total Force, the Active Reserve component plays a vital role in ensuring reserve units can augment, reinforce, and sustain their active component counterparts. Marine Corps Order 1001.52K, Active Reserve Support to the United States Marine Corps Reserve states the mission of the AR is to “provide a cadre of well-trained and experienced RC Marines to serve as a critical piece of the Marine Corps’ full-time support to the RC Force, and assist the AC with their Total Force integration roles and responsibilities” (p. 1-1).

D. ACCESSION AND RETENTION IN THE ACTIVE RESERVE

The AR component of the reserve force consists of approximately 2,500 Marines. Reserve Affairs Management (RAM) branch is ultimately responsible for managing AR inventory and structure. Marines serving in the SMCR, IRR, IMA, and AC may apply for accession through their local Prior Service Recruiter or Career Planner. Chapter 3, paragraph 2 of MCO 1001.52K explains in detail the basic qualifications a Marine must meet to be eligible for service in the AR. Marines who access into the AR typically serve an initial assignment of 48 months. Finally, MCO 1001.52K states that if a Marine is filling a career path MOS, they “may submit for reenlistment and apply for career designation” (p. 3-3).



1. Enlisted Career Force Controls

Each year, Reserve Affairs (RA) publishes a Active Reserve Enlisted Career Force Controls Program Marine Administrative Message (MARADMIN) detailing the various elements of AR ECFCs. One of the primary ECFCs and an element of my research is the Date of Rank (DOR) Adjustment. According to the yearly Active Reserve Enlisted Career Force Controls Program MARADMINs, RA will adjust the date of rank for Marines in the grades of Corporal through Gunnery Sergeant. According to the Active Reserve Enlisted Career Force Controls Program MARADMIN 480/22, these adjustments help ensure a Marine's experience matches their rank upon accessing into the AR (MARADMIN 480/22). ECFCs also help shape inventory by grade and MOS, standardize promotion flow across MOSs, help retain the best and most qualified, and comply with end strength requirements (MARADMIN 480/22). Comparison of multiple years of ECFC MARADMINs found virtually no substantive changes in DOR adjustments. Further, recent correspondence with RAM has indicated that 72% of Corporals and Sergeants who accessed into the AR were subject to DOR adjustments in Fiscal Years 2021 and 2022.

a. Date of Rank Adjustment

As noted above, most Corporals and Sergeants will be subject to a DOR adjustment. Below are excerpts from the Fiscal Year 2023 Active Reserve Enlisted Career Force Controls Program MARADMIN (MARADMIN 480/22).

- Reserve Corporals with MOS match will have DOR adjusted to AR accession date.
- Reserve Sergeants with four or more years and an MOS match will have rank adjusted by subtracting active duty time by accession date.
- Reserve Sergeants executing a lateral move to a new MOS will have DOR adjusted to match date of accession into the AR.



- Reserve Sergeants with less than four years of accumulated service will be accessed into the AR as a Corporal with a DOR determined by Reserve Affairs Personnel Policy, Plans, and Programming branch.
- AC Corporals accessing within 90 days of their release from active duty will retain their original DOR
- AC Corporals accessing after 90 days and who are an MOS match will have DOR adjusted by subtracting their active duty time in grade from their date of accession into the AR.
- AC Corporals who execute a lateral move will have DOR adjusted to their date of accession into the AR.
- AC Sergeants who are MOS matches and join within 90 days of being released from active duty will retain their original DOR.
- AC Sergeants approved for lateral moves will have their DOR adjusted to match their accession date.

Further details about the DOR adjustments can be found in the yearly MARADMINs.

2. Retention and Career Designation

Retention in the AR is unique from the SMCR and AC in that continued service by a Marine requires career designation. Membership in the RC is required for future retention. Marines requesting reenlistment will file for extension or reenlistment to RA. RA will determine the continuation of an AR Marine based on the needs of the AR program. An AR Marine will successfully achieve career designation if RA approves their reenlistment. According to HQMC, MCO 1001.52K, achieving career designation allows a Marine to earn an active-duty retirement at 20 years of service, assuming they continue to be promoted within the parameters set by RA (p. A-1).



3. Promotions

According MCO 1001.52K, “AR Marines compete for promotion in separate competitive categories meaning they only compete against other eligible AR members” (p.3-4). Enlisted promotions are determined by known and forecasted vacancies. Finally, enlisted promotions are linked to occupational field allocations. HQMC, MCO 1001.52K explains that the “small nature of AR MOSs can significantly speed up or slow down the promotion process in comparison to a Marine’s AC and other RC counterparts” (p. 3-4).

4. Quality Assessment of AR Accessions

Given the way in which Marines are accessed into the AR, a final screening is conducted to ensure a Marine is qualified for independent duty. The term independent duty does not mean the Marine will be working alone; rather, independent duty refers to an assignment to a location that is not found at a large installation and does not typically have the resources found on these larger installations. The Marine is usually the only one in his or her work section. SMCR, IRR, and AC Marines are screened by Prior Service Recruiters and the Inspector-Instructor staff at reserve sites. Marines desiring to access into the AR are required to submit NAVMC 11710 Commanding Officer’s Screening/Interview Guide. This form is used primarily to screen applicants. The form provides commanders and RAM an assessment of whether a Marine is likely to be successful on independent duty. According to Lieutenant Colonel Michael Becker, a manpower planner at Reserve Affairs, “RAM views the quality of Marines they receive from prior Service Recruiters as low” (M. Becker, personal communication, August 6, 2022). This is based primarily on the result of the NAVMC 11710. A Marine wishing to access into the AR could be viewed as “non-high quality” for a number of reasons but it is typically tied to medical issues, prior misconduct, financial hardship, or negative recommendations from a Marine’s former Commanding Officer and Senior Enlisted Advisor.

E. CONCLUSION

The AR plays a vital and unique role in ensuring the RC can fulfill its obligations to the total force. AR Marines typically serve on small staffs in areas far from the amenities of larger military installations. The accession, retention, and promotion processes of the



AR all help ensure the best and most qualified Marines are being accessed. However, recent trends seem to indicate accession quality is low. The rest of this research looks at the relationship between accessions, attrition, and quality. The next chapter discusses previous, relevant research conducted on this subject.



III. LITERATURE REVIEW

A. INTRODUCTION

Measuring the quality of enlisted Marines who access into the AR is difficult primarily because one person definition of quality may differ from someone else. There are many characteristics such as prior legal issues, fitness report relative value, and proficiency and conduct marks associated with a quality AR Marine. As noted in the previous section, RAM measures quality largely using the results of the screening form for independent duty. Quality has been defined in a number of ways in previous studies. For example, several studies use a combination of PFT, CFT, AFQT, and PRO/CON or FITREP RV to measure quality. This review analyzes the previous research on accession, attrition, and quality in the Armed Services, with a particular focus on measurement of quality, retention, and attrition.

B. STUDIES ON THE RESERVES

1. Reserve Affiliation and Application to Active Reserve

The reserve component is unique in that Marines desiring to serve choose to affiliate to a specific reserve component. Examples of this are the SMCR, IMA detachments, and even the IRR. The AR is maned from the active component or one of the three reserve components; there is no direct enlistment into the AR.

Against this background, several studies have studied why individuals choose to affiliate with a component of the reserves. For example, Hattiangadi et al. (2006) found that of the total population of AC Marines who separated in the years studied, only 0.4% ended up in the AR. They also found that of those Marines affiliated in the IRR, 6% would go on to join the AR (Hattiangadi et al., 2006). Further, they found that 1.4% of those affiliated with SMCR units would go on to separate and later join the AR (Hattiangadi et al., 2006). Though their focus was on attrition in the SMCR, Hattiangadi et al. provide valuable insight into where Marines end up after separating.



In another study Dolfini-Reed and Schulte, (2012) looked at the interaction between prior-service Marines and affiliation in to the SelRes. Between 2001 through 2011, 8.5% of AC Marines chose to affiliate with SMCR units or IMA billets. Further, the majority of enlisted Marines in paygrades E-3 to E-5 spent one to six months in the IRR before affiliating with the SelRes (Dolfini-Reed & Schulte, 2012). They reached these conclusions by using aggregated data from TFDW. This study has many valuable insights about affiliation behavior of enlisted Marines. This includes the relationship between time spent in the IRR and the propensity to affiliate with the SelRes, measures of quality as they define it such as level of education and what tier and Marine is designated as for reenlistment. Further their use of survival analysis is helpful in its application to studying affiliation behavior of Marines. However, the study did not delineate which component of the SelRes, Marines affiliate with. There is mention of SMCR units and IMA billets however, no specific mention is made of prior-service Marines joining the AR.

Affiliation is unique to the reserve component. Studying trends in affiliation provides us with a better understanding of how, when, and why Marines may choose to affiliate with the SelRes and more specifically the AR.

2. Accession Quality Studies

Researchers have defined quality in many ways to measure fitness for a particular job or duty. There is congruence across some of the measures however, the different measures of quality in the literature are largely predicated on one's environment, experience, and reason for defining quality. I explain below how RAM defines quality as it relates to AR accessions. Then I discuss the definition of quality in recent work by Becker (M. Becker, personal communication, August 6, 2022) and Stolzenberg (2017).

a. Defining Quality

As noted above, RAM uses Marine Corps Order (MCO) 1326 and a screening form to determine one's eligibility for service in the AR. This form has basic demographic data but also contains information on a Marine's past performance including PFT and CFT scores, financial stability, past medical history, past legal history, and an assessment of the Marine by the gaining command (HQMC, 2021). The assessment is a subjective review of



the applicant's ability to perform in the AR. It is conducted by the applicant's commander and senior SNCO for the Marines seeking to affiliate with the AR. Currently, RAM views the quality of AR applicants as low. This perception of non-high quality is based primarily on the information in the screening form. Overall, the screening checklist is effective at screening applicants in a basic sense however, much of the information is subjective in that it relies on the opinions of senior leaders which could be biased, and it also assumes the applicant is completely truthful in the personal information they disclose such as their financial situation.

Three recent studies on the reserves all use different measure of quality. In particular, Becker measures quality using a descriptive analysis of performance evaluations, commendations, training performance, education, and career statistics (M. Becker, personal communication, August 6, 2022). While he uses many of the same independent variables as other research, his study is unique in that it applies these variables to better understand reserve officers and the way in which they affiliated to the SelRes. Using individual Total Force Data from TFDW he estimates t-tests, quantile regressions, and survival analysis models to determine if there is statistically significant difference between those reserve officers with prior service time and those without. But he finds no statistically significant difference in the performance of reserve officers with prior active service and those without.

While Becker studies reserve officers (M. Becker, personal communication, August 6, 2022), Stolzenberg (2017) identifies key factors that predict promotion to Lieutenant Colonel (Stolzenberg, 2017). Similar to Becker, he considers FITREP RV scores, PFT and CFT scores, Marksmanship scores, and education among many other explanatory variables. These variables are largely objective measures of performance like PFT and CFT scores and awards and these measures are important in predicting promotion and measuring quality. Across these studies, the same independent variables are used to capture the effect of quality on different outcomes such as promotion to LtCol or performance of reserve officers. Finally, Stolzenberg notes that "Quality is a nebulous term that has different meanings to different people or organizations and statistical analyses of quality may not capture the whole picture" (Stolzenberg, 2017). Though measuring quality



may be nebulous, it is not futile and Stolzenberg provides a kind of warning to researcher about the limitation of datasets and statistical methods.

3. Reserve Retention and Attrition Studies

Many studies have looked at retention and separation in the USMC. This issue is of particular importance for the AR because of the relatively small number of Marines in the AR and the requirements to affiliate specifically, acquiring a new MOS and in many cases, being administratively reduced in grade to maintain MOS and grade health in the AR. In many instances the Marine Corps will access and train Marines to fill specific jobs in the AR. Losing these Marines has significant costs and can also lead to adverse effects in more senior ranks. If the Marine Corps is unable to retain these junior Marines after their initial commitment, how will the AR maintain a cadre of more senior enlisted Marines? Therefore, some studies have looked at the determinants of attrition and retention in the Reserves.

Unlike attrition, few studies specifically look at the determinants of retention. Though studies of attrition help us glean information about why a Marine may remain in the service, one cannot draw hard conclusions without further analysis. Though retention and attrition may be two sides of the same coin, we cannot say there is a pure inverse correlation between the cause of either retention or attrition. This means that incentives to retain Marines don't necessarily work across the board. There is a wide range of reasons why a Marine may leave the service just as there many reasons one will continue to serve.

Since 2012 there have been three studies that looked specifically at retention and attrition in the reserves. The first is the second volume by Dolfini-Reed et al., (2012) discussed above. Where the first volume studied affiliation behavior, the second volume studies continuation or retention and attrition. Having addressed the issue of affiliation, Dolfini-Reed et al., (2012) seeks to answer, "which Marines remain in the SelRes, for how long, and what factors may be influencing their retention decisions" (Dolfini-Reed, 2012). Combining survival analysis models with data on prior service Marines or those that leave active duty and affiliate in some way with the SelRes, they model the likelihood that a Marine will leave the SMCR as a function of months spent in IRR prior to affiliation with



SelRes, SelRes activation, measures for quality, and unemployment rate (Dolfini-Reed et al., 2012).

Of all the findings, the ones most relevant to this study is among enlisted Marines in the SelRes that were activated. They found that Lance Corporals had the lowest rates for attrition followed by Sergeants. However, these same ranks had highest rates of attrition if they were ever activated. This finding is important to my study because the population I will study is primarily Lance Corporals through Sergeants. This study would be more informative if the researchers had indicated if the Marines were strictly in the SMCR or IMA billets. This would allow for grater observation of which component in the SelRes Marines serve in.

Another important finding by Dolfini-Reed et al., (2012) is that prior service Marines that are considered high quality and have never been activated are less likely to leave the SelRes than non-high-quality Marines (2021). Of the same population but having been activated for a time, the researchers found that those considered high quality are more likely to leave than those that were activated but are considered lower quality (Dolfini-Reed, 2012). But this study does not delineate between different components of the SelRes which would be useful to have a better understanding of which component of the SelRes has the most attrition.

Another study by Korkmaz and Ugurbas (2015) studied the determinants of first-term attrition for Marines in the SMCR. Using individual data and probit regression models, they found that “being married or divorced and having above a high school education are related with higher attrition among enlisted Marines.” They also find that “higher PFT scores and being part of a combat unit also led to higher rates of attrition among enlisted Marines” (Korkmaz & Ugurbas, 2015). They found that having a dependent and being older all reduced the probability of attrition for first-term enlisted Marines. Like (Dolfini-Reed et al., they find that rank is important in predicting attrition. Contrary to Dolfini-Reed et al., they find that higher levels of education are associated with higher probability for a Marine to attrite in their first term. Though not an equal comparison in the two studies, this finding is noteworthy for future analysis, particularly of the effect of education on one’s decision to leave the service.



C. CONCLUSION

Previous research identifies common independent variables that measure quality such as FITREP relative values, PFT and CFT scores, and education. These measures were all predictive across the studies though some studies found differing effects, specifically when using education as a measure. However, measures such as FITREP relative values and PFT and CFT scores were equal in measuring quality and predictive of attrition.

Building on these techniques and measures of quality I study measures of quality and length of service in the AR. No previous research has exclusively studied the relationship between quality, and retention and attrition in the AR. Thus, my research addresses an important void in the literature.



IV. DATA AND METHODOLOGY

A. DATA DESCRIPTION

1. Data Sources

All data for this study is provided by HQMC Total Force Data Warehouse (TFDW). TFDW is the primary repository for personnel and training data that is collected by various systems across the Marine Corps. TFDW is comprised of multiple data tables which are essentially columns that represent a variable. The data is stored by sequence number which is a monthly snapshot in time and by an individual's ID such as social security number or Electronic Data Interchange Personal Identifier (EDIPI).

2. Data Management

The data for this study includes TFDW sequences 263 to 394, which are equivalent to monthly snapshots of any Marine that ever served in the AR from January 2011 through December 2021. I merge the TFDW data with fitness report data from Manpower Management Records and Administration (MMRP) Branch. After merging the two datasets, there are 572,403 longitudinal observations of 4,864 individual Marines. The initial data set is in panel form, organized by a Marine's EDIPI and the sequence number for each observation. Using the merged data I then clean the data for analysis. I drop Marine-month observations instances of where an invalid entry was made. For example, some instances of FITREP relative value at processing had a value of zero or 9999. These are erroneous values were dropped. In other cases, I carry forward the last observed value of a particular instance. This was done with variables that do not change over the course of a Marines career such as gender or height. I drop variables that were of no value to my research such as AFQT test type. I also exclude Marines in the grades of E-8 through E-9.

The final dataset includes 3,180 Marines who were in service in the AR component from January 2011 to December 2021, amounting to 208,959 Marine-month observations with 136 variables. Finally, Stata 17 was used for all data cleaning and analysis.



3. Dependent Variables

My main analysis estimates a Cox Proportional Hazards Model. For this survival analysis, attrite simply means that a Marine exits the AR. I am not concerned as to why they leave or if they transition to a different component; my goal is to characterize how attrition is related to quality. For Cox regression models, the dependent variable is comprised of two parts; time to event and an indicator for when the event happens. I create a variable that measures length of service in the AR using minimum and maximum sequence numbers to calculate the length of service in the AR. This variable is continuous and gives the required time to event measure. I generate a binary variable using component codes to determine when a Marine enters and exits the AR. The attrition indicator and length of service in the AR give me the dependent variables needed to perform the analysis. Table 1 below describes the characteristics of the dependent variables for the entire data set.

Table 1. Description of Dependent Variables

Dependent Variables					
	Observations	Mean	SD	Min	Max
Attrite	208,959	0.01	0.08	0	1
AR Service Length	208,959	44.94	32.46	1	132

4. Independent Variables

With the dependent variables created, I then estimate several Cox regressions. The models are broadly split between Corporals and Sergeants. The independent variables I use to observe attrition consist of a measure that indicates a Marine is high quality, gender, MOS, whether a Marine was subject to disciplinary action and whether they ever received a personal award. I define a high-quality Corporal as a Corporal that has mean PFT and CFT scores above 235 and average proficiency and conduct marks of 4.5 and above. As I note in the literature review, there are myriad ways in which one can define quality. After reviewing the literature and analyzing the data, the measures I define, best represents how the Marine Corps would define a Marine as high quality.



Male is a binary variable and is equal to one if a Marine is male. I split each MOS into three broad categories. The first is combat arms and contains all infantry, combat engineer, artillery, tank and AAV MOSs. The second category is combat service support and contains administrative, intelligence, logistics, communication, engineer, armorer, and supply MOSs. The final category contains all MOSs associated with aviation. The disciplinary action variable is binary and indicated whether a Marine was ever subject to NJP or any kind of court martial. The final variable is also binary and indicates whether a Marine has ever received a personal award at or above the level of a Navy and Marine Corps Achievement Medal. Table 2 displays the independent variables for Corporals.

Table 2. Description of Independent Variables for Corporals

Independent Variables for Corporals					
Variables	Observations	Mean	SD	Min	Max
High Quality Indicator	38,193	0.42	0.49	0	1
Male	38,193	0.9	0.30	0	1
CSS MOS	38,193	0.73	0.44	0	1
Combat MOS	38,193	0.03	0.17	0	1
Aviation MOS	38,193	0.24	0.43	0	1
Disciplinary Action Indicator	38,193	0.08	0.27	0	1
Personal Award Indicator	38,193	0.31	0.46	0	1

Similar to Corporals, I define a high-quality Sergeant as having average PFT and CFT scores above 235 and FITREP relative values at processing equal to 93.33 or greater. With the exception of FITREP relative value, all other variables have the same definition as those for Corporals. Table 3 shows the summary statistics for the Sergeant independent variables.



Table 3. Description of Independent Variables for Sergeants

Independent Variables for Sergeants					
Variables	Observations	Mean	SD	Min	Max
High Quality Indicator	82,767	0.42	0.49	0	1
Male	82,767	0.88	0.32	0	1
CSS MOS	82,767	0.71	0.45	0	1
Combat MOS	82,767	0.03	0.18	0	1
Aviation MOS	82,767	0.26	0.44	0	1
Disciplinary Action Indicator	82,767	0.12	0.32	0	1
Personal Award Indicator	82,767	0.67	0.47	0	1

B. METHODOLOGY AND MODELS

The primary goal of my research is to determine the effects of quality on attrition among AR Marines. The populations of interest are Marine Corporals and Sergeants that have served in the AR. The method by which I assess quality and attrition is through Cox Proportional Hazard models.

Cox Proportional Hazards Models are a subset of the broader field of survival analysis within the field of statistics. In their textbook on survival analysis, Kleinbaum and Klein (2005) give a basic definition of survival analysis as “a statistical procedure for data analysis for which the outcome variable of interest is time until an event occurs” (Kleinbaum & Klein, 2005). In my research, I use the variable AR Service Length to calculate the time until the event occurs. AR Service Length is measured in months. The event, also referred to as failure, is when a Marine is no longer serving in the AR. I define this event or failure as attrition from the AR. The event variable is dichotomous and is equal to one in the month or sequence number when a Marine exits the AR and zero otherwise. I specify time to attrition and the event of attrition occurring for each panel and unique Marine. In his multivariate data analysis textbook, Massenkoff (2022) gives the basic survival function as

$$S(t) = P(T > t),$$

“[w]here T is non-negative random variable denoting time to an event and $S(t)$ is the probability that a unit is still in its initial state following time t ” (Massenkoff, 2022).



In my model, T is length of service in the AR and the initial state is defined as being in the AR.

Having the time to event and occurrence of event variables, I estimate a series of Cox regressions. Other survival analysis techniques do not allow for regressors, are only useful for categorical variables, or assume a certain parametric form of the survival function. The Cox Proportional Hazard Model makes no assumption about the parametric form of the survivor function $S(t)$, letting the data tell what the shape of this function is. In addition, the Cox model allows me to use a framework similar to standard regressions that estimate the probability of failure or the probability of the event under observation occurring as a function of other characteristics or covariates, not just time. The only assumption is that the covariates multiplicatively shift the baseline hazard, hence it is called a Cox proportional hazard model. Kleinbaum and Klein (2005) describe the usefulness of Cox regression as “a “robust” model, so that the results from using the Cox model will closely approximate the results for the correct parametric model” (Kleinbaum & Klein, 2005). A parametric model simply stated, is a model of probability distributions with a definite number of parameters. A linear regression is but one example of a parametric model. So, the usefulness of the Cox model is that it closely approximates the outcome of a linear regression making interpretation relatively straightforward. The equation below represents the Cox Proportional Hazard Model I estimate.

$$h(t | X) = h_0(t)e^{\sum_{i=1}^p \beta_i X_i}$$

According to Kleinbaum and Klein (2005), “the Cox formula says that the hazard at time t is the product of two quantities. The first quantity is the baseline hazard and defined as $h_0(t)$ which is estimated nonparametrically. The second quantity is the exponential expression e to the linear sum of $\beta_i X_i$ where the sum is over the explanatory X variables” (Kleinbaum & Klein, 2005).

Following the Cox Proportional Hazard Model, I display the kernel density estimates for Corporals and Sergeants. The Kernel density estimate allows me to display the distribution of high-quality Corporals and Sergeants who serve beyond the initial



service obligation of 48 months compared to non-high quality Corporals and Sergeants. I also conduct two-sample Kolmogorov-Smirnov (K-S) tests of the equality to determine whether the two density plots are in fact different. Next, I estimate and display the length of service for Corporals and Sergeants who access into the AR as a Corporal or Sergeant. I display this by rank, gender, race, and MOS. Finally, I show the proportion of Corporals and Sergeants who eventually attrite from the AR.

C. CONCLUSION

This chapter describes the data and models I estimate. I explain where the data came from and how I clean the data. I then detail how I merge the data and create variables. I present the dependent and independent variables used for the model I estimate. Finally, I detail the methodology used to answer my research questions. In the next chapter, I present my findings.



V. RESULTS

A. INTRODUCTION

In this Chapter I present the findings of my research questions. I first show the Cox Proportional Hazards Model along with the Kernel density plots. I then show and describe the service length trends among Corporals and Sergeants. Finally, I display and discuss findings for the level of attrition among Corporals and Sergeants.

B. GENERAL TRENDS

As previously noted, the relatively low number of unique instances makes some of the analysis difficult or unfeasible. Specifically, there is no indicator available to show whether a Marine was subject ECFC measures upon accession into the AR. Unsurprisingly, the data clearly shows a positive trend between length of service and the likelihood of attrition. That is, as a Marine serves longer, the likelihood of attrition increases in each time period.

C. RESULTS FROM ANALYSIS

1. Cox Proportional Hazards Model for Quality of Accessions

a. *Model for Corporals*

Table 4 shows results of the series of survival models I estimate for Corporals. In the first column, I estimate the hazard rate for a high-quality Corporal to exit after 48 months. In the second to fourth columns, I add controls for gender, MOS, legal action, and awards.

In general, hazard ratios below 1.00 indicate a lower probability of failure in the next time period. As Table 4 shows, the only statistically significant indicator is the measure of whether a Marine is considered high quality. In the final model with all indicators (Model 4), I find that holding all else constant, a high-quality Corporal who serves beyond the initial service obligation of 48 months is 88% less likely to attrite in the next time period. Though the other indicators lack statistical significance, they are all above



1.00. This indicates that all of these predictors would lead to a higher probability of failure in the next time period.

Table 4. Probability of Attrition for Corporals after 48 Months

	Model 1	Model 2	Model 3	Model 4
High Quality Cpl	0.135** (0.100)	0.137** (0.103)	0.138** (0.104)	0.120** (0.091)
Male		1.101 (0.890)	1.143 (0.931)	1.037 (0.889)
CSS MOS			1.166 (0.543)	1.051 (0.498)
Subject to Disciplinary Action				2.605 (1.340)
Personal Award				1.213 (0.529)
Observations	899	899	899	899

Hazard Ratios Listed & Standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Meanwhile, although the other indicators lack statistical significance, they are all above 1.00. This indicates that all of these predictors would lead to a higher probability of failure in the next time period. For example, a Corporal who has served beyond the initial service obligation of 48 months and has been subject to disciplinary action is 2.6 times more likely to attrite in the next time period than a similar Corporal who has never had a disciplinary action.

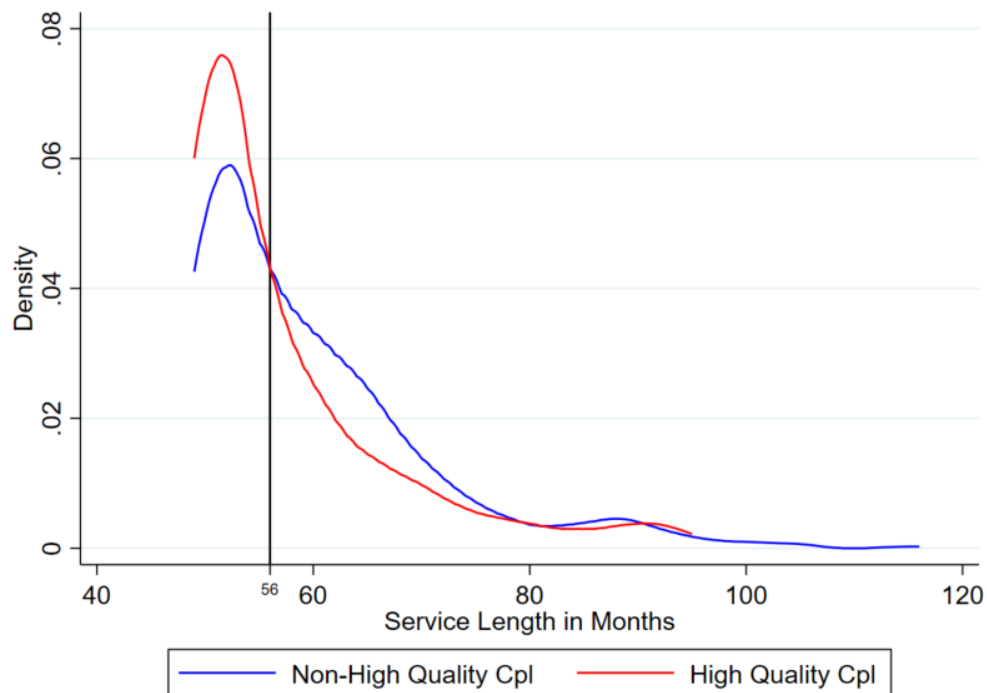
The Kernel density plot is given below in Figure 2 and shows service length in months separately for high-quality Corporals and non-high quality Corporals. I find that high quality Corporals who serve at least 48 months continue to serve in the AR in greater proportion to non-high quality Corporals. However, this trend only continues to 56 months of service at which point the proportion of high-quality Corporals is lower than that of non-



high quality Corporals. I employ the K-S test to systematically test the hypothesis that AR service length for non-high quality Corporals is greater than for high-quality Corporals throughout the distribution or density of service lengths. In Figure 2, this K-S test tests whether the blue line is statistically significantly to the right of the red line. Results from the two-sample (K-S) test show that, at the 95% confidence level, I can reject the null hypothesis that densities of non-high quality Corporals are larger than (or shifted to the right relative to) high-quality Corporals.

Finally, as noted earlier, the high-quality indicator for Corporals is comprised of mean PFT and CFT and proficiency and conduct marks in grade. Taken individually, the only statistically significant variables are proficiency and conduct marks. These underlying variables drive the statistical significance of the high-quality variable. Thus, I conclude that job performance as measured by the proficiency and conduct marks a Marine receives drives the relationship between quality and attrition.

Figure 2. Length of Service for High- and Non-high Quality Corporals



b. Model for Sergeants

I repeat the same process for Sergeants, estimating multiple Cox regression models. Table 5 shows results of the series of survival models I estimate for Sergeants.

Table 5. Probability of Attrition for Sergeants after 48 Months

	Model 1	Model 2	Model 3	Model 4
High Quality Sgt	1.343* (0.166)	1.344* (0.166)	1.342* (0.166)	1.441** (0.181)
Male		1.082 (0.242)	1.078 (0.243)	1.048 (0.238)
CSS MOS			0.985 (0.135)	1.045 (0.144)
Subject to Disciplinary Action				0.975 (0.178)
Personal Award				0.535*** (0.079)
Observations	25285	25285	25285	25285

Hazard Ratios Listed & Standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

As Table 5 shows, the indicator for both high quality and having a personal award are statistically significant. The indicator for high quality has a hazard ratio greater than one which indicates that high-quality Sergeants who have served beyond their initial service obligation have a higher likelihood of attrition compared to non-high quality Sergeants. In the final model with all indicators (Model 4), I find that holding all else constant, a high-quality Sergeant who serves beyond the initial service obligation of 48 months is 44% more likely to attrite in the next time period. Furthermore, a Sergeant who receives a personal award and serves beyond the initial service obligation of 48 months is 46.5% less likely to attrite in the next time period.



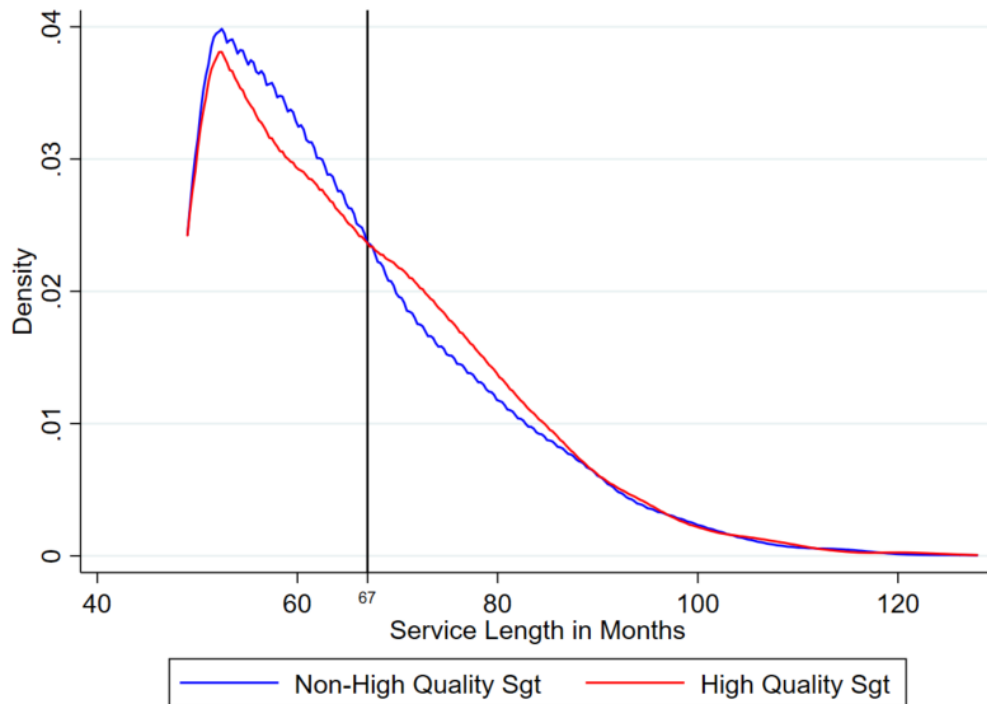
Meanwhile, although the other indicators lack statistical significance, they are all above 1.00 with the exception of disciplinary action. This indicates that all of these predictors would lead to a higher probability of failure in the next time period. For example, a Sergeant who has served beyond the initial service obligation of 48 months and is male is 1.04 times more likely to attrite in the next time period than a similar Sergeant who is female. Additionally, a Sergeant who has served beyond the initial service obligation of 48 months and has been subject to disciplinary action is .97 times less likely to attrite in the next time period than a similar Sergeant who has never had a disciplinary action.

The Kernel density plot is given below in Figure 3 and shows service length in months separately for high-quality Sergeants and non-high quality Sergeants. I find that non-high quality Sergeants who serve at least 48 months continue to serve in the AR in greater proportion compared to high-quality Sergeants. However, this trend only continues to 67 months of service at which point the proportion of non-high quality Sergeants is lower than that of high-quality Sergeants. I employ the K-S test to systematically test the hypothesis that AR service length for non-high quality Sergeants is less than for high-quality Sergeants throughout the distribution or density of service lengths. In Figure 3, this K-S test tests whether the blue line is statistically significantly to the left of the red line. Results from the two-sample (K-S) test show that, at the 95% confidence level, I can reject the null hypothesis that densities of high-quality Sergeants are larger than (or shifted to the right relative to) non-high quality Sergeants.

Finally, unlike the high-quality indicator for Corporals, there is more underlying the high-quality indicator for Sergeants. Taken individually, mean PFT and FITREP relative value at processing are statistically significant and drive the statistical significance of the high-quality indicator variable. I conclude that job performance as measure by FITREP relative value and PFT score drive the relationship between quality and attrition.



Figure 3. Length of Service for High- and Non-high Quality Sergeants



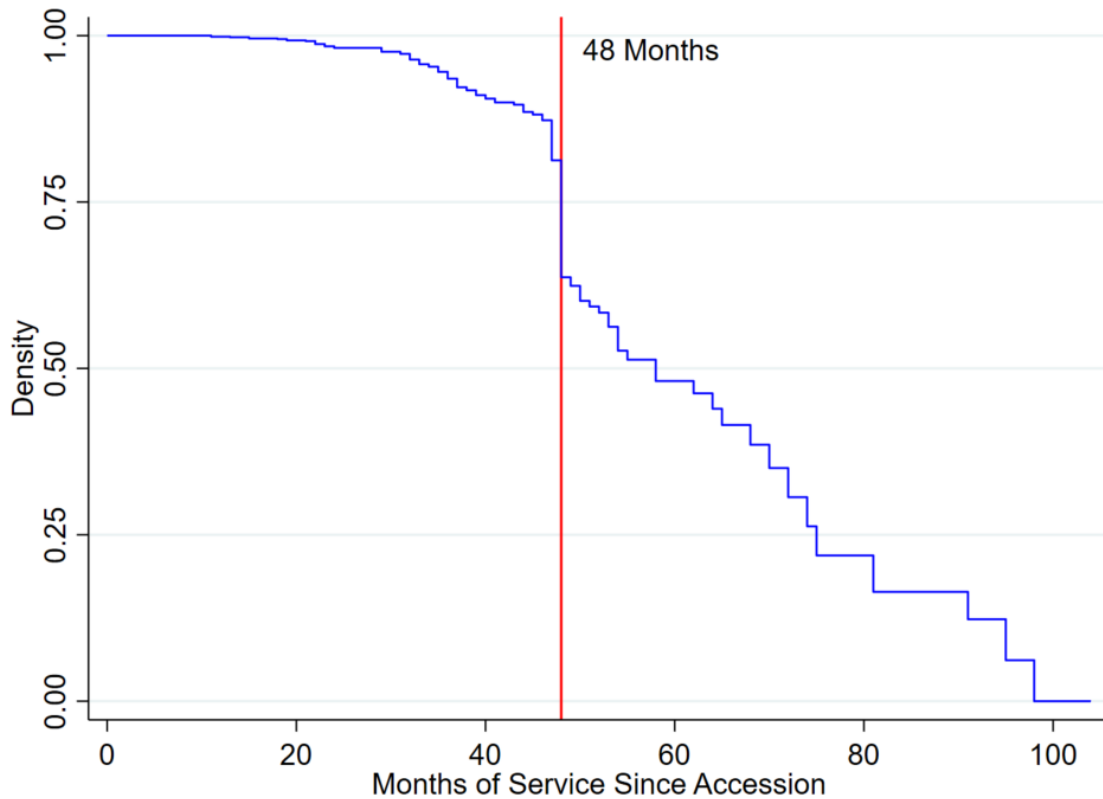
2. Length of Service after Accession into AR

a. Length of Service for Marines that Access as Corporals

The next research question asks what the length of service is for a Marine that accesses into the AR as either a Corporal or Sergeant. I determine this using the component code and length of service variables given the Marine is a Corporal. When a Marine that accesses into AR they receive a component code of B1. This code will change once they leave.

Figure 4 shows the length of service for Marines that access into the AR as a Corporal. As expected, there is significant decrease in the number of Corporals still serving after 48 months as many choose to leave the AR after their initial service obligation. After 98 months, there are no Corporals left that accessed into the AR as Corporals. This is largely due to promotion and attrition.

Figure 4. Months of Service Since Accession for Corporals

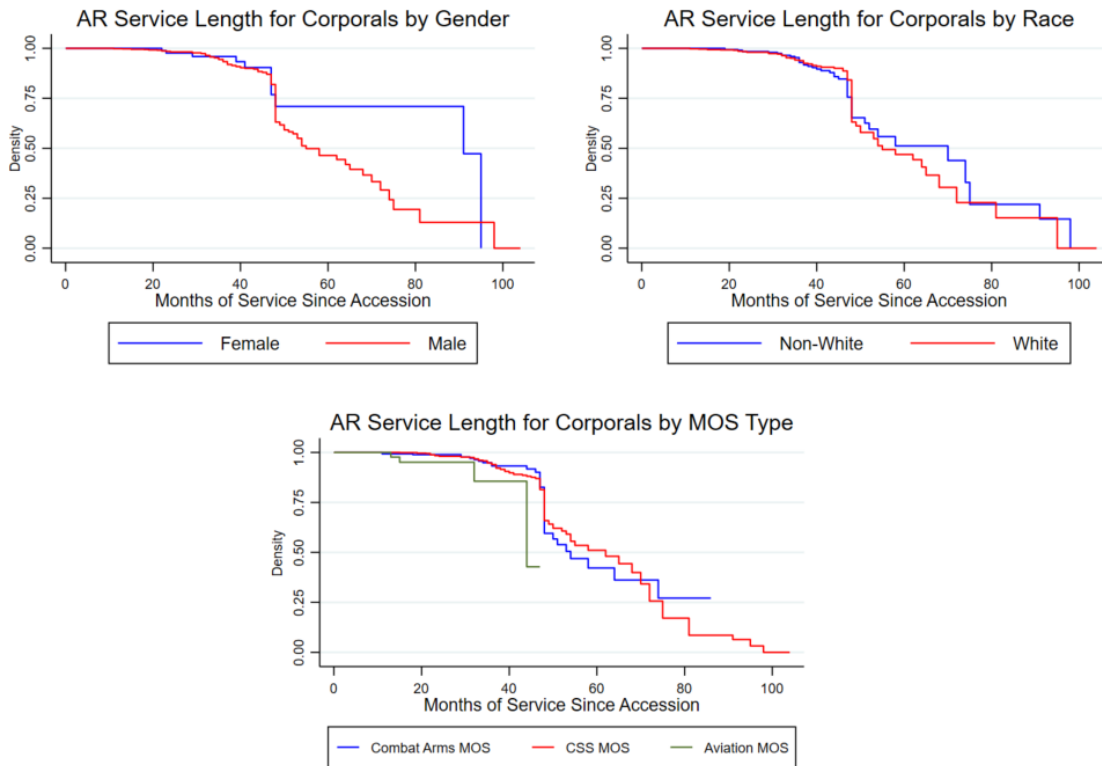


Next, I show the length of service for Marine who access as a Corporal by gender race, and MOS. For all three categories I find the same trend of significant attrition at 48 months. Male Corporals exit at slightly higher rate than females. However, for the duration of the study there were only a total of 172 females compared to 1,461 males that accessed into the AR as a Corporal. Service length by race among Corporals is similar up to 60 months when non-whites continue to serve at slightly higher rates. There were 1,088 white Corporals compared to a total 474 Corporals of all other races. Lastly, service length among Corporals is shown by MOS group. I separated MOS into three broad categories, Combat Service Support, Aviation, and Combat Arms. Corporals in Combat Service Support MOSs make up the vast majority of AR Corporals. There were 1,235 Marines in CSS MOSs compared to 70 and 365 Marine Corporals in Combat Arms and Aviation MOSs, respectively. Within the CSS MOS, Marine Corporals primarily filled



administrative, armory, and supply billets as nearly every reserve site requires these types of MOSs.

Figure 5. Months of Service Since Accession by Demographics (Cpl)



b. Length of Service for Marines that Access as Sergeants

I repeat the steps for analyzing length of service of Marines that access as a Corporal for Marines that access into the AR as Sergeants. Figure 6 shows the length of service Marines who access into the AR as a Sergeant. Though not as big of a decline as Corporals, we see a similar trend of attrition at the 48-month mark, once a Sergeant has met their initial service obligation.



Figure 6. Months of Service Since Accession for Sergeants

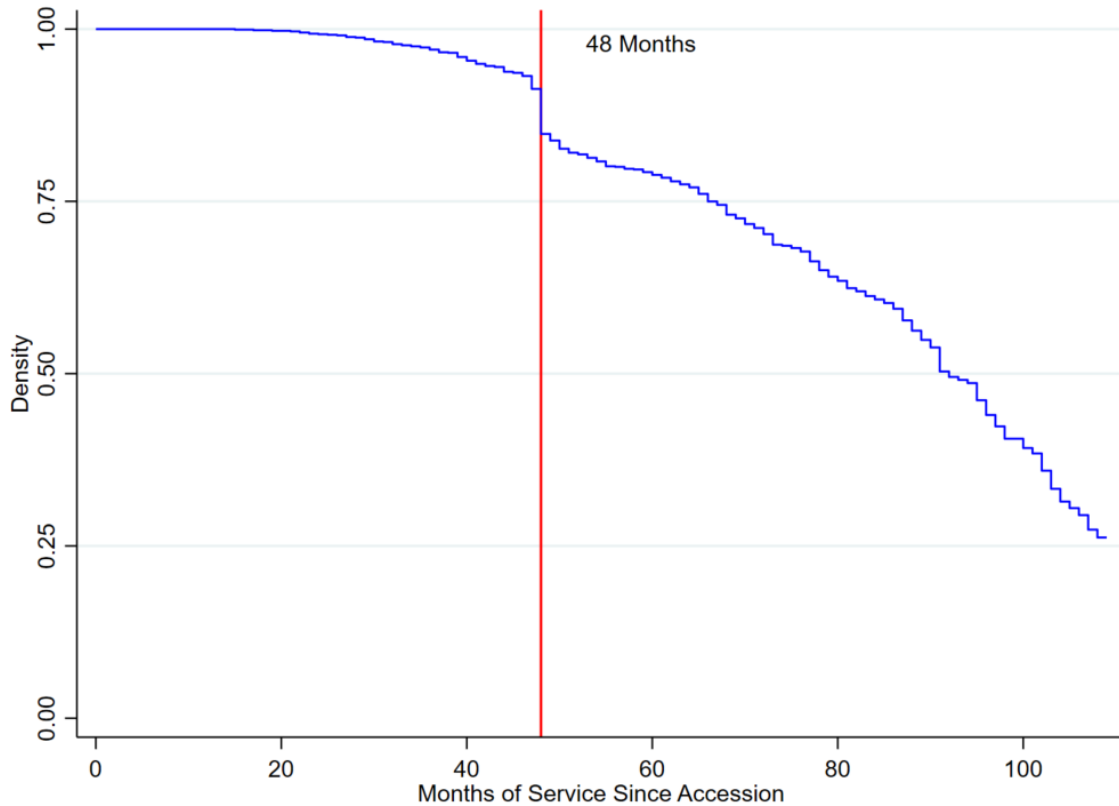
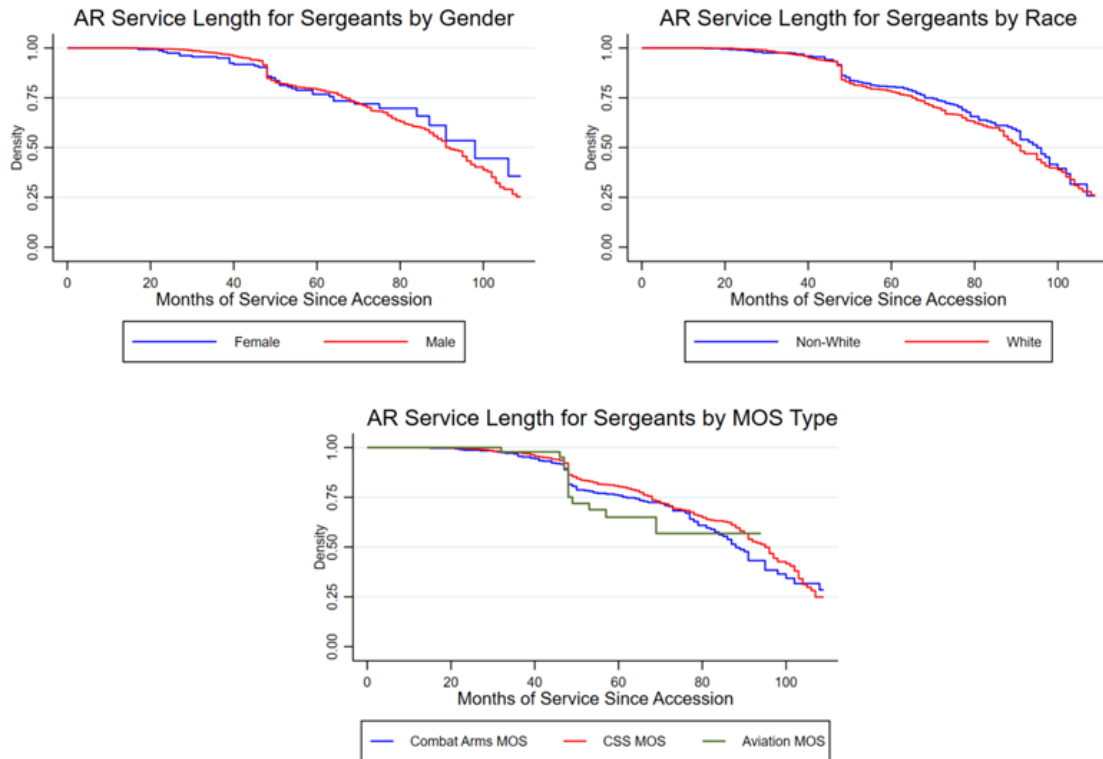


Figure 7 shows the length of service for Marines who access into the AR as a Sergeant by gender, race, and MOS. Male Sergeants exit at slightly higher rate than females though their trend is similar. For the duration of the study there were only a total of 273 females compared to 1,937 males that accessed into the AR as a Sergeant. Service length by race among Sergeants is practically similar up to 48 months when non-whites continue to serve at slightly higher rates. There were 1,471 white Sergeants compared to a total 790 Sergeants of all other races. Lastly, service length among Sergeants is shown by MOS group. MOS is separated into three broad categories, Combat Service Support, Aviation, and Combat Arms. Sergeants in Combat Service Support MOSs make up the vast majority of AR Sergeants. There were 1,601 Marines in CSS MOSs compared to 108 and 562 Marine Sergeants in Combat Arms and Aviation MOSs, respectively. Like the Corporal population, Sergeants in CSS MOSs primarily filled administrative, armory, and supply MOSs.



Figure 7. Months of Service Since Accession by Demographics (Sgt)



3. Attrition Trends between Corporals and Sergeants

Finally, I show at the rates of attrition among those Corporals and Sergeants that accessed into the AR as a Corporal or Sergeant. Figure 8 shows the rates of attrition and retention for all lengths of service.

I find that 11% of Corporals and 35% of Sergeants who ever access into the AR at those ranks, attrite at any given time. Figure 9 shows the rate of attrition for Corporals and Sergeants that serve beyond 48 months.

I find that 3% of Corporals and 30% of Sergeants who accessed into the AR at those ranks and serve beyond 48 months, attrite during the study time period.

Figure 8. Percentage of Cpl and Sgt Who Ever Attrite

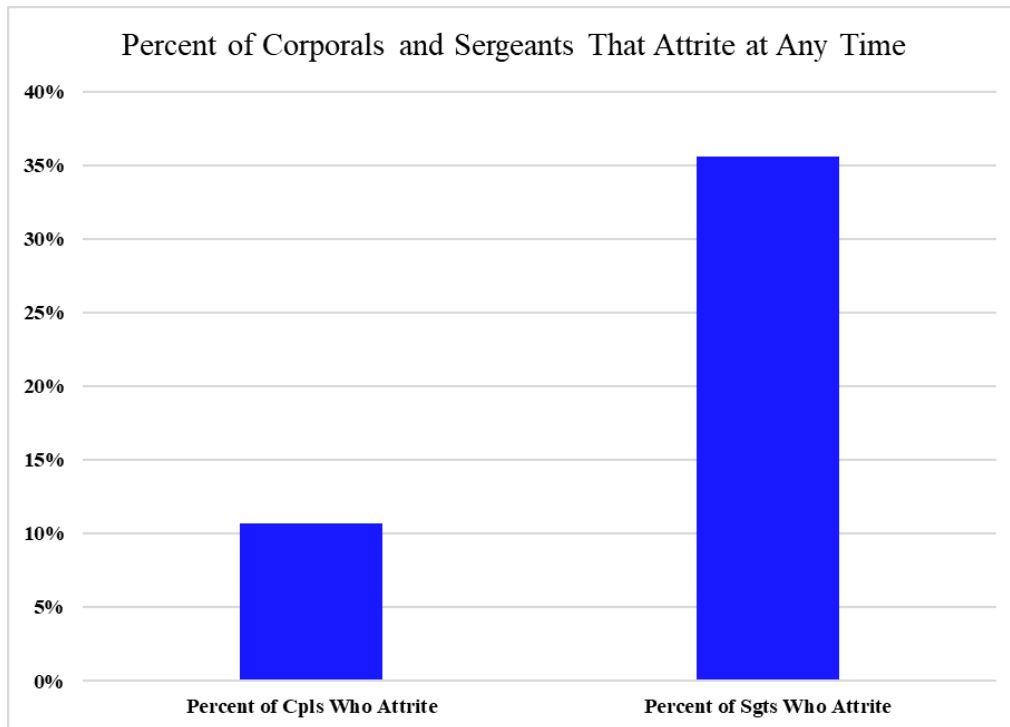
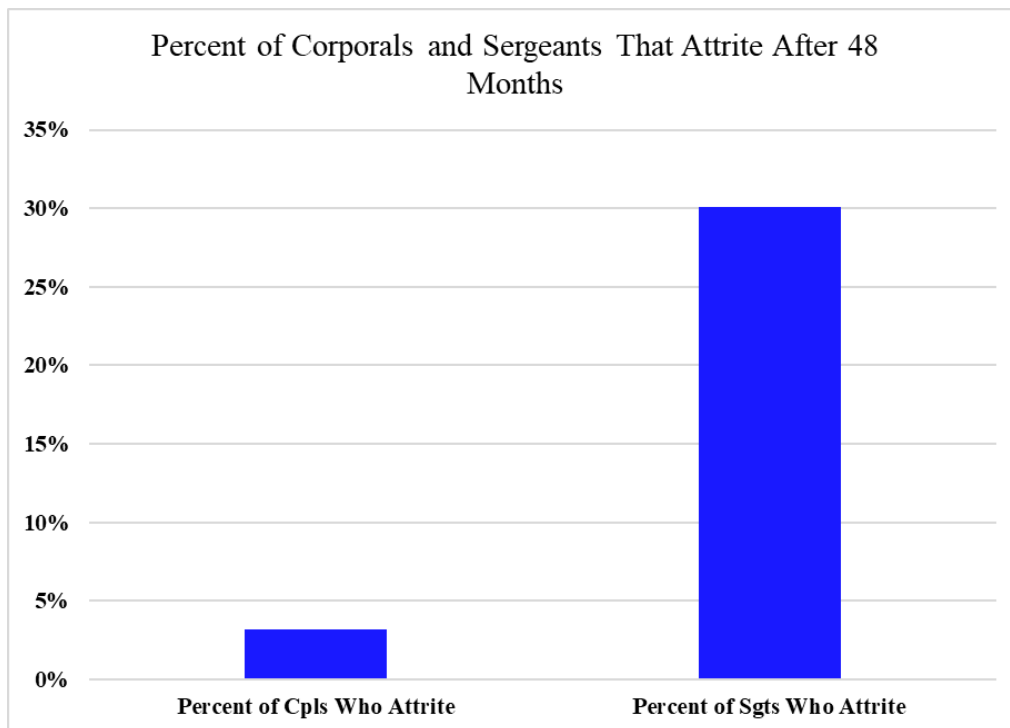


Figure 9. Percentage of Cpl and Sgt Who Attrite after 48 Months



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VI. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION

The main purpose of my study was to determine the relationship between quality and attrition among AR Marines. Manpower Reserve Affairs believes that Marines who currently access into the AR are not high quality. My findings contradict this notion for Corporals who served at least 48 months based on my definition of high quality. To show the relationship between quality and attrition I use survival analysis techniques with an emphasis on Cox Proportional Hazards Models. I also provide kernel density plots and survival plots to examine length of service and the effect of various categories has on a Marines length of service.

Among Corporals, those designated as high quality serve in greater proportion than all others up to 56 months at which point non-high quality Corporals continue to serve in greater proportion. Though not part of the study, one explanation for why non-high quality Corporals serve in greater proportion after 56 months is that the high-quality Corporals have been promoted to Sergeant and thus fall out of the study population. Further study could be conducted to conform this. If found to be true, then it suggests the AR is at least promoting the type of Marines they wish to retain.

Among Sergeants, the findings are somewhat different. Based on my definition of a high-quality Sergeant, those who are high quality serve in slightly lower proportion to non-high quality Sergeants. High-quality Sergeants who serve beyond their initial service obligation are also more likely to attrite than non-high quality Sergeants. This trend remains until 67 months of service in the AR. One of the underlying factors that contributed to a Sergeant being high quality was a FITREP relative value of 93.33 or higher. A Sergeant that is newly promoted is unlikely to receive such a high score for their first FITREP. This could produce the slightly lower number of high-quality Sergeants initially. Finally, a simple summary of the performance data on Sergeants indicates that there are very few that one might label as “non-high quality.” These Sergeants could generally be categorized by having below a first class PFT and CFT and in the lower one third of FITREP relative



values. This further contradicts the perception held by Reserve Affairs about the quality of Marines in the AR. As with the Corporal population, Reserve Affairs appears to be positively identifying and retaining high-quality Sergeants. Finally, the Marines accessing into the AR could in fact be non-high quality as determined by reserve Affairs. However, based on my research, by the time they reach their initial service obligation, the majority are high quality as I have defined the term.

Next, Survival plots showing length of service share a common trend with a pronounced departure from the AR at the 48-month mark. One would expect these results gives that most initial contracts in the AR are 48 months long. I also provide length of service for Corporals and Sergeants by gender, race, and MOS. I show the percent of attrition by rank of Corporals and Sergeants that accessed into the AR at those. I also find a common trend of attrition after a Marines initial service obligation had been met. Finally, I show the rates of attrition for Corporals and Sergeants who access into the AR at those ranks.

B. RECOMMENDATIONS AND FURTHER RESEARCH

1. Effect of ECFC Measures

At the onset of this study, I sought to show the impact ECFC measures have on retention and attrition. A detailed explanation of these measure was provided in the background chapter. The Marine Corps does not currently track in an intelligible way, whether or not a Marine was subject to these measures. Valuable insight into the effect of these measures on the health of the AR can be gleaned if a signal was created to show this in a Marine's record.

2. Retention of High-Quality Sergeants

Further study could be conducted to determine the reason why high-quality Sergeants that have met their initial service obligation leave the AR at higher rates than non-high quality Sergeant. Understanding this would help Reserve Affairs tailor incentives to help retain these high-quality Sergeants. This could also tie into further studies that try to determine why Marines leave the AR and where they go afterwards.



3. Interaction between High-Quality Indicators and Other Predictors

During the conduct of my research, I researched the effects of interaction between being a high-quality Corporal or Sergeant and other predictor variables. All the findings yielded statistically insignificant results however, further study could be conducted to find other predictors that help explain attrition among Corporals and Sergeants. Further studies could include more variables that make up a high-quality Marine.



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