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**THESIS**

**DEPARTMENT OF THE ARMY CIVILIAN EMPLOYEE  
ATTRITION IN CALENDAR YEAR 2009**

by

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March 2019

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**DEPARTMENT OF THE ARMY CIVILIAN EMPLOYEE ATTRITION IN  
CALENDAR YEAR 2009**

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## **ABSTRACT**

Despite the importance of human capital to the Department of Defense and U.S. Army, we do not have much research on civilian attrition—the reduction of workforce due to termination, resignation, retirement or death. Identifying attrition patterns helps organizations assess policy effects and organizational culture and forecast future workforce needs. This study analyzes attrition rates for Department of the Army (DA) civilian employees for the calendar year (CY) 2009 using a logistic regression model and multinomial logistic regression model and finds a 5.5% attrition rate for DA civilians in CY 2009. The study also finds that younger and older employees have a higher attrition rate, which corresponds to previous findings in our literature review. This study also shows that employees with lower credit federal service time (FS) were more likely to leave compared to those with a higher FS. Higher attrition among employees with less FS may be due to the fact that these employees are not fully invested in federal service. The study provides data and recommends helping DA leaders assess attrition patterns and causes among DA civilian employees which will, in turn, help to forecast future DA civilian employees' strength.

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## **LIST OF ACRONYMS AND ABBREVIATIONS**

AAG-RFL	Army Analytics Group Research Facilitation Lab
BLS	Bureau of Labor Statistics
CRS	Civil Service Retirement System
CY	Current Year
DA	Department of Army
DoD	Department of Defense
FERS	Federal Employees Retirement System
FY	Fiscal Year
GS	General Schedule
MRA	Minimum Requirement Age
NSPS	National Security Personnel System
OPA	Office of People Analytics
PDE	Person-Event Data Environment
PII	Personal Identifiable Information
SES	Senior Executive Service
UIC	Unit Identification Code
VERA	Voluntary Early Retirement Authority
VSIP	Voluntary Separation Incentive Payments
ZIP	Zone Improvement Plan

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## **I. INTRODUCTION**

The Department of Defense (DoD) civilian workforce offers critical support to our armed forces. A big organization, DoD employs nearly 800,000 civilians (DoD, 2015) so effective workforce management is essential to meeting organizational goals, current and future. The DoD uses tools such as policies to manage DoD civilian workforce (Cho & Lewis, 2012). Analysis of attrition, that is the reduction of the workforce due to termination, resignation, retirement, or death, can help measure the effectiveness of these tools. Better tools allow planners to better predict overall organizational health, culture, cohesiveness, and job satisfaction. Attrition data can also measure the effectiveness of recruitment, retention, and management processes. While the idea of quitting sounds negative, when controlled, attrition can have a positive impact. For example, if an employee has tenure in a high paying position but is not productive, their attrition would lower personnel costs making room for a new employee.

This study examines attrition among DoD civilian employees who worked for the U.S. Army in the first quarter of calendar year (CY) 2009. Specifically, we study any person who appeared in our data with a general schedule (GS) and band employee rank classification, then left in CY 2009 through termination, transfer, resignation, retirement, or death.

### **A. BACKGROUND**

Learning attrition patterns can help DoD control cost, help in future planning, and mitigate contributing factors. Though attrition can be a positive, attrition can also mean the loss of critical skills, the loss of managerial skills, the creation of a knowledge gap, and a lower productivity level.

In recent years, the DoD civilian workforce's challenges include drawdowns, policy changes, and an aging population (Dye & Lapter, 2013). The U.S. Army, the largest DoD civilian workforce employer, has experienced the largest effect from these challenges. After every war, the Army faces budget cuts that lead to workforce reduction to reduced labor costs (Cho & Lewis, 2012). To reduce the workforce, the Army uses force shaping

tools such as early retirement, pay freezes, and hiring freezes. These tools can have negative long-term effects on the workforce. Hiring freezes shut young employees out of the system, increasing the number of older employees, creating the risk of having a percentage of aging personnel.

An aging workforce is a particular issue of concern for DoD because most baby boomers are approaching retirement age. Being eligible to retire does not always translate to actual retirement as previous studies have shown. Only 9 percent of those eligible to retire actually retire each year (Cho & Lewis, 2012). Studying attrition patterns based on retirement makes it possible for organizational leaders to forecast future workforce needs and mitigate the loss of critical and managerial skills. The retirement rate between both employees at GS-15 pay grade and the Senior Executive Service (SES) was almost double the average retirement rate for the overall federal workforce since FY 2008 (Dye & Lapter, 2013). Most of the personnel retiring have tenure and hold managerial positions, and the loss of managerial experience negatively affects the DoD.

Attrition is also expensive for any organization. Pay freezes can cause employees to leave depending on the job market outside of the federal government. When unemployment is low, employees experiencing pay freezes have more job options especially when there is an opportunity for better pay and job promotions. This can be attributed to talent loss which leads to overall mission ineffectiveness, training and recruiting of new employees cost among others. Talent loss or leaving a position vacant can cause job dissatisfaction that increases the probability that other employees may attrite. One study points out that when people leave, they cause others to work harder and this contributes to more attrition (Goswami & Jha, 2012). When people migrate to other employers, the DoD incurs extra costs for recruiting, selecting, and hiring new employees. These employees have to be trained which can be costly as well depending on job type and previous experience. There is no concrete amount of DoD employee replacement cost although, based on private sector estimates, the cost could run from 50 percent to 200 percent of the employees' annual salary depending on the position (Cho & Lewis, 2012). It is also important to note that, due to the recession of years 2007–2009, some of the people

eligible for retirement may not have been able to retire due to their investments taking a hit from the economic recession.

## **B. PROBLEM AREAS AND RESEARCH GAP**

The literature review in this study shows that, although Army attrition is widely studied, researchers have concentrated mainly on uniformed personnel rather than on Army civilian employees. The few studies look at attrition based on DoD policies and aging workforce and are not specific to the Department of Army (DA). The U.S. Army is the largest organization in the DoD with its own micro-culture, so analyzing its civilian attrition is important.

## **C. PURPOSE**

Human capital is an important resource for U.S. Army mission accomplishment. Identifying factors that cause attrition and their impacts help leaders to understand their organization better and forecast workforce needs. This study identifies the employees who meet retirement eligibility and actually retire in CY 2009. We identify employees who leave in CY 2009 due to other factors other than retirement such as resignation and termination or disciplinary issues. Finally, we estimate the probability of an employee leaving in CY 2009 as a function of his age, retirement eligibility and other demographic factors.

## **D. METHODOLOGY**

This study uses a logistic regression model to estimate the probability of attrition in 2009. The Army Analytics Group Research Facilitation Lab (AAG-RFL) through the Person-Event Data Environment (PDE) provided the data, which originated from Defense Manpower Data Center (DMDC). The data comprises Army civilian master files, which are quarterly snapshots, and Army civilian transaction files, which are transactions added to civilian employee records each time a new transaction occurs. The scope for this study is DA civilians employed in the CY 2009 and had a quarterly snapshot in the first quarter 2009. This data helps identify factors that contribute to attrition and the attributes of

employees most likely to attrite. Variables analyzed in this study are age, federal credited service time, sex and education.

#### **E. FINDINGS OF THE STUDY**

Overall attrition in this study is 5.5 percent. This study shows higher attrition among younger employees, an attrition slow down and then increase after an employee turns 50 years of age. This pattern is consistent with previous studies. The study also shows that just because an employee meets retirement eligibility it does not mean that they would retire. Our data is limited due to lack of personal identifiable information (PII) such as number of dependents, life insurance and Unit Identification Codes (UIC). This information would have been useful to assess organizational effectiveness such as organizational culture as well as effects of changes in policies. Lack of life insurance or type of health insurance enrollment are indicators that the employee might be a second income earner, which could lead to a higher likelihood of attrition. Our study only covers a span of one year. This limits our ability to tell how long it takes a retirement eligible employee to retire. It is also impossible for us to tell how economic and policy changes affect attrition rate in our study. However, this study sets the stage for forecasting the number of retirements and separations in the next calendar year. Future studies should compare attrition from different years with CY 2009 to measure effects of economic and policy changes.

#### **F. SUMMARY**

The DA has conducted extensive attrition studies on attrition for active duty personnel in comparison to DA civilian attrition. Data used in this study is also limited in the sense that key information such as personal identifiable information (PII) is not available. This information is important for future studies in order to identify organizational systematic issues that leads to attrition as well as predict personnel decision to attrite or not to attrite. This study reviews past studies on attrition, organizational theories, policy changes, data and methodology, results and then conclusion.

## **II. LITERATURE REVIEW**

DoD civilians play an important role in the defense of our nation in support of the Armed forces. The Army, Navy, Air Force, Marines, and other DoD agencies have nearly 750 occupations positions that offer diverse careers (DoD, 2015). In recent years, the DoD civilian workforce has faced attrition challenges due to drawdowns, budget cuts, and aging population among others. In this chapter, we review past studies conducted on causes of attrition, causes of resignation, aging workforce, theories of organizational theories, and generational differences.

### **A. PAST STUDIES**

Although DoD civilian workforce has been in existence since 1776 (Army Career, n.d.), there are very few studies conducted on civilian workforce turnover or retention in comparison to active duty military personnel. Most studies addressing DoD civilian workforce discussed effects of changes in policies such as hiring freezes, pay freezes, GS system changes to band pay systems, drawdowns, an aging workforce, and generational differences.

#### **1. Drawdowns**

Historically, the DoD downsizes after every war. This is the case in the 90's during President Clinton's administration and then again during President Obama's. Empirical studies of turnover in the federal workforce have found that government-downsizing policies (Ertas, 2015) disproportionately affects younger employees. Stability and attractiveness of DoD jobs lessens during this period. Younger workers tend to migrate to more appealing positions outside of DoD because they have higher quit rates on average, because they are more flexible in terms of career choice and typical life obligations such as family and finances (Ertas, 2015). Tools used to help in downsizing are hiring freeze, pay freeze, use of voluntary separation incentive payments (VSIP), and voluntary early retirement authority (VERA). These tools can accelerate the rate of aging Army civilian workforce by reducing the number of younger people hired or would like to work for the Army. Lytell et al. (2015) state that,

DoD's reliance on hiring constraints and voluntary attrition to achieve civilian reductions in the 1990s led to demographic, as well as skill, imbalances. In particular, the drawdown resulted in an older civilian workforce. The median age of DoD civilian employees rose from 41 in 1989 to 46 in 1999, and the number of civilians under the age of 31 dropped by 76 percent during the same period, while the number of those aged 51–60 remained about the same.

## **2. DoD Budget Cuts**

DoD budget cuts forces agencies to implement ways to control spending by offering early retirement options, retirement plan changes, hiring freezes, cuts to training, eliminating overtime as well as bonuses. Implementation of these policies may cause unwanted results by extrinsically affecting their employees. This leads to job dissatisfaction that can cause an increase attrition rate. The Budget Control Act of 2011 forced different measures such as pay freezes, early retirement options authorization, cuts to training, elimination of overtime or bonuses and furloughs (Dye & Lapter, 2013). Due to Budget Act of 2011, the Army announced that they would need to reduce 40,000 soldiers from a total force of 490,000 to 450,000 and cut 17,000 civilian jobs as part of their force structure and stationing decisions (DoD, 2015).

Change in policy does not have to be a negative. The DoD uses early retirement and special incentive options as a way to control the attrition rate. Most people who are eligible for early retirement are normally on a high ranking meaning higher pay. By getting them to retire, the DoD saves on personnel cost. Some employees who meet this eligibility criterion and have other better opportunities might take advantage of these authorizations. Voluntary Separation Incentive Payment (VSIP) option is attractive to an employee who was not planning to stay on as a federal employee. Voluntary Early Retirement (VERA) is the early retirement option. Most VERA eligible employee meet creditable federal time but are short in years. Most people who meet this category are employees with honorable prior service. If a competitive market exists in the economy, it is easy for an employee who has met the early retirement option to choose early retirement when offered.

## **B. RESIGNATION**

Resignation happens when an employee voluntarily chooses to terminate their employment from an organization. Understanding factors that lead to an employee resignation is important to an employer if they want to retain and attract good employees. Lack of job and financial security is one of the drivers that would cause employees to resign their positions in search of a more stable opportunity. Changes in pay or talks about pay reduction, is a deterrence to personnel who possess critical skills. This may cause retention and recruiting setbacks for DoD agencies. Job and financial insecurities may be a result of sequestrations, pay freezes and retirement changes. In 2013, sequestration led to unpaid furloughs for some civil service workers, including those at the DoD (Asch, Mattock, & Hosek, 2014a). Asch et al. (2014a) conducted a study to see how pay freezes retirement plan changes affected DoD civilian employees retention in the long run. The results showed that among GS employees with four years of college or more, only 7.3 percent projected to stay with the federal service despite time in federal service, which was lower than had there been no pay freeze.

Lack of meaningful work leads to disengaged employees that causes dissatisfaction and raises the odds for an employee to resign (Dye & Lapter, 2013). DoD policies have not evolved to accommodate younger generations. Difference in priorities and a feeling of lack of inclusion may lower employee's motivation and job satisfaction and cause resignation. The economy has also improved with low rates of unemployment. This means that DoD compensation packet has to compete with the market otherwise recruiting and retention becomes more and more difficult.

## **C. AGING WORKFORCE**

The aging workforce is a continuous concern for the Army civilian workforce. Federal employment grew by 15 percent between 1965 and 1985, which coincides with the time baby boomers entered the workforce (Cho & Lewis, 2011). This employment surge of mainly baby boomers are currently eligible for retirement. Twenty-six percent of the Federal workforce was 55 years or older in fiscal (FY) 2013 compared with 16 percent in

FY 2000 (Dye & Lapter, 2013). Other factors that have contributed to the aging workforce is the Federal employment downsizing.

An aging workforce tends to mean a higher retirement rate. This thins the pool of organizational knowledge, contributing to a skills gap among high-skilled workers such as economists, financial auditors, acquisitions, science, technology, engineering, mathematics and human resources (Dye & Lapter, 2013). Army civilian employees eligible for retirement are mostly in management positions. Retirement of these employees causes loss of managerial skills.

#### **D. THEORIES OF ORGANIZATIONAL POLICIES**

Work environment plays a major factor on employee retention, recruitment and job satisfaction (Strategies for Managing Change, n.d.). Employees resign when other opportunities offer greater rewards than their current job. Rewards in this case may include better pay, shorter commute to work and closer proximity to family. The opportunity cost an employee would incur by changing jobs is an example of cost in this case study (Cho & Lewis, 2012). It is imperative for an organization to understand what motivates an employee to stay in an organization or to resign due to high cost of recruitment, selecting, hiring and training new employees not to mention knowledge gap when a seasoned employee chooses to retire. A work environment in which an employee experiences job satisfaction must meet both intrinsic and extrinsic needs of an employee.

Maslow's motivation theory defines these needs best and states that lack of either could lead to lack of job satisfaction and in the end cause the employee to resign (Strategies for Managing Change, n.d.). Organizations need to understand what motivates an employee to stay in an organization or to resign due to high cost of recruitment, selecting, hiring and training new employees not to mention knowledge gap when a seasoned employee chooses to retire. A work environment in which an employee experiences job satisfaction must meet both intrinsic and extrinsic needs of an employee. Intrinsic needs are inborn.

## **1. Maslow's Motivation Theory**

Abraham Maslow developed the famous motivation theory—also known as the hierarchy of needs—between 1943 and 1954 (Strategies for Managing Change, n.d.). This theory states that human beings have a hierarchy needs and must fulfill individual needs before they tackle other complex needs (Strategies for Managing Change, n.d.). Maslow motivation theory is a pyramid with five steps (Strategies for Managing Change, n.d.). The steps are as follows starting from lowest level to highest level: physiological, safety, belongingness and love, esteem and self-actualization needs as seen below.

### ***a. Physiological Needs***

These are the basic needs for an individual to survive (Strategies for Managing Change, n.d.). These are the primary needs in Maslow's pyramid. Examples of physiological needs are food, water, air among others. Lack of these needs leave human beings feeling unsettled and they must take care of these needs in order to think about other things.

### ***b. Safety Needs***

In the second level of Maslow theory pyramid are security and safety. Security and safety are important to human beings because they establish stability and consistency in our lives. Financial and physical security, mental and physical health and a safe environment are among safety needs. Safety programs and flexible schedules can help meet safety needs (Fore, Reedy, Sanchez-Vahamonde, & Whelan, 2016).

### ***c. Belongingness and Love Needs***

Belongingness and love needs are part of psychological human needs. Human beings all over the world have a need to feel loved and accepted. Organizations should incorporate networking as part of orientation to allow new employees to meet old employees. This encourages human connection as well as transfer of knowledge. Transferring knowledge in an informal setting allows new employees to engage without fear of apprehension. Most organizations have new employee orientation programs to fulfil

this need. Unfortunately, orientation programs focus on data dumping or organizational compliance training sessions (Goswami & Jha, 2012).

Organizations can create high-quality connections through a change of culture and power of values. A culture that values and rewards teamwork, value development of people, value the whole person, and finally value respect and dignity of others is a way of making employees have a sense of belongingness.

*d. Esteem Needs*

Self-esteem results from competence or mastery of a task as well as good opinion of other people (Strategies for Managing Change, n.d.). This in return reduces the feeling of inferiority and negativity. To fulfill this need, employers can provide feedback and recommendations on an employees' performance to allow the employee room for improvement. Having a reward system for employees for a job well done also boosts the employees' morale and provide motivation.

*e. Self-Actualization*

It is difficult to determine one's full potential. Maslow believed that when people have all their physiological and psychological needs met, they tend to progress towards fulfillment of their full potential (Strategies for Managing Change, n.d.). Self-actualization is more personal than the other needs. One has pursue peace within and outside oneself, appreciate life and all it brings, self-fulfillment and knowledge among others.

**2. Herzberg Motivation Theory**

Herzberg motivation theory also coined, as the two-factor theory believes that people have higher and lower levels of needs. These two factors are motivation (satisfaction) factors and hygiene (dissatisfaction) factors (Education Business Articles, 2016). These two factors have no relationship with each other where lack of one does not mean that you have the other factor (Education Business Articles, 2016). Leaders must ensure to fulfill these two factors for their organizations to be successful.

**a. *Hygiene Factors***

Although hygiene factors are essential for job motivation, they do not lead to long-term job satisfaction (Strategies for Managing Change, n.d.). Examples of hygiene factors are policies, pay, work relationship, work conditions, status, job security, leadership and policies. Hygiene factors could affect attrition and recruitment of new employees. These factors are extrinsic to work. Pay freezes enacted in the FY 2011 by the DoD, not only affected pay increases but retirement compensation as well. Asch, B. et al. (2014b) in their study note that DoD civilian workforce experienced three consecutive years of pay freezes since 2011 with a 1 percent pay increase for 3 consecutive years from 2014 and personal contribution towards retirement rose to 4.4 percent. The rise in personal contribution was to help the government on the cost of FERS at 12.7 percent of pay (Asch et al., 2014b). DoD as an employer needs to make sure that the pay and compensation package can compete with the market if they want to retain and recruit quality employees. People enjoy workplaces where they feel like they feel recognized and compensated for their effort. Organization norms are also a big factor. Leaders must encourage quality work relationships, provide great work conditions and create policies that are fair to everyone.

**b. *Motivation Factors***

Motivation factors not only yield positive job satisfaction but also are intrinsic to work. These factors inspire employees to give their best job performance improving the organization's bottom line. Examples of motivational factors are job advancement, responsibility, achievement, growth, and recognition. Since motivation factors focus more on job satisfaction, it is important that leaders empower their employees, delegate as well as improve job roles to keep workers motivated.

Lack of training leads to poor performance therefore no rewards. This can lead to lack of confidence for the employee and employer. This is due to failed expectations leading to job dissatisfaction. Providing feedback to employees shortens the feedback loop, helps to keep performance level high, and reinforces positive behavior (Goswami & Jha, 2012). Setting unrealistic goals or realistic goals without any guidance on how to accomplish the goals causes employees' frustration and lowers job motivation.

Personal expectations such as growth and upward mobility are also important to employees. Studies have shown that “employees do not leave if they feel that the work they are doing is important, if they are happy on and off work, and they have a good relationship with their supervisor” (Fore et al., 2016). Most people prefer a challenging position that broadens the base of their domain expertise to money. Lack of growth may make the employee feel stifled and lead to resignation. Personal needs are important as highlighted by both Maslow and Herzberg. Lack of work balance and high levels of stress makes employees stressed out and lead to exiting the organization for a more relaxed pace opportunity.

## **E. GENERATIONAL DIFFERENCES**

DA civilian employees with prior military service takes up to 30% of the total DoD civilian workforce. The other seventy percent of the employees either come straight from college or transfer from other organizations in the federal government. Due to the range of ages, Army civilian workforce has a range of age groups such as baby boomers, ‘Gen Xers’ and the millennials. Baby boomers are people who were born between the years of 1946 and 1964. ‘Generation Xers’ are people born in 1965 to 1979 and millennials are the work force born 1980 to 2000 (Miller-Merrell, 2016). Of all generations represented in the work place today, millennials tend to require the most attention. They emphasize preference for unconfined careers, work-life balance and extrinsic rewards (Ertas, 2015). A preference for unconfined careers and the fact that they have not invested a lot of time in their jobs makes them a high target for attrition. Studies have shown that attrition rates are higher among employees who have less than 5 years of federal experience (Cho & Lewis, 2012).

Different generations require different retention and recruitment strategies. In a Federal Employee Viewpoint survey conducted in 2012, Baby Boomers prefer financial incentives while ‘Gen Xers’ and millennials prefer promotion and job advancement as well as workplace flexibility programs (Dye & Lapter, 2013). A customized retention strategy for mission critical workers to cater to difference in priorities for different workforce generations is essential.

Engaged employees are involved and committed in their work, personal growth and organizational growth (Dye & Lapter, 2013). These types of employees do not require being micromanaged. They invest in furthering their organization's interests, working smarter and are willing to put in extra time to get the job done. Leaders can improve the job satisfaction for this generation by increasing the motivation factors and reduce hygiene factors. With an aging workforce headed to retirement, the majority of workforce will comprise of mostly millennials eventually. This makes retention of millennial workforce critical.

## **F. SUMMARY**

Our literature review discusses DA civilian employees' causes and patterns of attritions from past studies, effects drawdowns after wars, effects of budget cuts, aging workforce, organizational theories and generational differences. This information gives us a focus on patterns we need to look for in our data in Chapter III.

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### **III. DATA AND METHODOLOGY**

This chapter discusses data collection and methodology used to study DA civilian attrition rate in CY 2009. AAG-RFL through the PDE provided the data, which originate from DMDC as stated earlier in Chapter I. The data is comprised of Army civilian master files, which are quarterly snapshots, and Army civilian transaction files. The logistic regression model in Chapter IV uses the dependent and independent variables from this data. This chapter covers summary statistics and data description.

#### **A. DATA DESCRIPTION**

This section describes variables used to measure attrition of DA civilians in CY 2009. Data available in the PDE contains monthly employment snapshots from 2005 to the first quarter of 2017 and transaction records from 2007 to the first quarter of 2017 (Buttery, Klingensmith, & Whitaker, 2018). The data of interest are all quarterly snapshots and transaction records between 1 January 2009 and 31 December 2009 for employees with a 31 March 2009 snapshot record. A random sample of 100,000 DoD civilian employees is taken from the original data. A subset containing only DA civilians with a rank General Schedule (GS) or BAND. This subset has 23,197 records.

The Naval Postgraduate School (NPS) Institution Review Board (IRB) determined this data to be free of PII, so the project is not human subject research according to the federal definition of research with human subjects 32 CFR 219. AAG-RFL also scrambled the UICs and Zone Improvement Plan (ZIP) codes to ensure the command and locations are unidentifiable.

Variables used in this study are age, date of birth, gender, start dates, rank codes, education, first transaction date, active duty dates, last transaction date and last transaction details. Age is computed by finding the difference between the snapshot date (SNPSHT\_DATE) and the birth date in the PDE (DATE\_BIRTH\_PDE) then dividing the result by 365.25 to convert the results to years or by using given PN\_AGE\_QY value (Buttery et al., 2018). Gender assignment is as follows: M for males, F for females, Z for personnel who switch genders and NA for missing genders (Buttery et al., 2018). Rank

codes used are GS and BAND. BAND rank is used because our data of interest falls in a period when DoD transitioned GS pay system to National Security Personnel System (NSPS) before it was repealed by the authority of the National Defense Authorization Act for FY 2010 (Clark & Whitman, 2011).

The last transaction date and details are taken from an employee's "last" transaction record up to the first quarter of 2017. The transaction details field describes the nature of the transaction. Employees whose last transaction date is before 31 December 2009 and whose transaction details indicate separation of some type have clearly separated from DoD employment in 2009.

Last transaction details indicating separation codes in this data are: death, reassignment, removal, resignation, resignation-in lieu of involuntary action, retirement disability, retirement-in lieu of involuntary action, retirement special option, retirement voluntary, separation RIF, separation US, separation incentive, termination, appointment termination, termination expiration of appointment, termination sponsor relocating, termination during probation period and transfer. Initial results show that 5.5% employees leave by the end of CY 2009. Of these, 14.3 percent of retired; 11 percent are forced out of federal service through termination during probation period, removed from current positions, resign to avoid removal; 34.1 percent separated due to death, resignation, separation incentive or separation RIF and separation U.S.

However, some employees have a final snapshot record in 2009 with no subsequent records after 2009 and no indication from their last transaction details that they have separated. We count these individuals as separated too. Note that an individual who is employed by DA at the beginning of 2009, then in 2009 is appointed to a position in different DoD component is also counted as separated. Of the 23,197 employees, 1,280 separate in 2009. Table 1 lists the last transaction details for these 1,280. We have organized the transaction details into four groups: retired, removal, other separation and not separation. The last group includes transaction details of employees whose last transaction details does not tell us why they left.

Table 1. Last Transaction Details for DA Employees Who Left in 2009

Type	Last Transaction Details	Number of DA Employees who left by End of 2009	Subtotals	Percentages
Retirement	Retirement Disability	29		
	Retirement Special Option	1		
	Retirement Voluntary	153		
	<b>Subtotal</b>		<b>183</b>	<b>14.3</b>
Removal	Removal	15		
	Resignation-in lieu of involuntary action	3		
	Retirement-in lieu of involuntary action	5		
	Termination	95		
	Termination during probation/trial Period	23		
	<b>Subtotal</b>		<b>141</b>	<b>11</b>
Other Separations	Death	23		
	Resignation	369		
	Separation RIF	5		
	Separation Incentive	21		
	Separation U.S.	18		
	<b>Subtotal</b>		<b>436</b>	<b>34.1</b>
Not Separations	Appointment not to exceed (date)	1		
	Change in data element	6		
	Change in Service Computation date	3		
	Change in Tenure group	5		
	Change to lower grade, level or band	5		
	Conversion to career- conditional appointment	1		
	Conversion to excepted appointment not to exceed (date)	3		
	Excepted appointment	1		
	Excepted appointment not to exceed date	6		
	Extension of appointment not to exceed date	32		
	Federal Employees group life insurance change	9		
	Group cash award	8		
	Individual cash award	53		
	Individual Time off award	7		
	Leave without pay U.S.	3		
	Leave without pay not to exceed date	3		
	Pay Adjustment	81		
	Promotion	1		
	Recruitment Incentive	2		
	Realignment	13		
	Reassignment	6		
	Retention Incentive	1		
	Regular WRI	16		
	Return to duty	1		
	Senior career employee rank award	36		
	Termination appointment Termination in (agency)	87		
	Termination Expiration of appointment	126		
Termination Sponsor relocating	4			
	<b>Subtotal</b>		<b>520</b>	<b>40.6</b>
	<b>TOTAL</b>	<b>1280</b>	<b>1280</b>	<b>100</b>

## B. LOGISTIC REGRESSION MODEL

Logistic regression models the probability that a binary response or dependent variable takes value 1 as a function of one or more explanatory or independent variables (Faraway, 2006). Our logistic regression model is used to examine the relationship between

the probability of attrition in CY 2009 and explanatory variables based on age, gender (Sex), federal years in service (FS), years until eligible for retirement (yearsIR), education level (Ed), rank code (RankCode), and whether the employee has prior active duty military service or not (PE). Logistic regression is often used to classify individuals using their estimated probability of attrition. Individuals whose estimated probabilities are greater than some threshold (often 0.5) are classified as attrited. We do not use the results of a logistic regression for classification; instead we use the estimated probabilities to give us a sense of which types of individuals are more likely to attrite.

Rather than use numeric versions of age, FS, and yearsIR we create categorical versions. Since age ranges from 17 years of age to 87.42 years, we partition age into categories with interval boundaries as follows: 17, 20, 25, 30, 35, 40, 45, 50, 55, 60, and 90 to construct the categorical variable ageFAC. FS has a range of 0 years to 58 years. The FSFAC explanatory variable is a partition of FS in interval partitions with the following boundaries: 0, 5, 10, 15, 25, and 60. Similarly, the yearsIRFAC is a categorical version of yearsIR with interval boundaries: 0, 1, 5, 10, and 40. The yearsIRFAC variable represents how many years an employee has until they are eligible to retire. Ed is a factor with four levels: 0 representing people without a high school diploma, 1 with high school diploma, 2 with a four year degree and 3 with a master's level or higher education. We fit a logistic regression with the following explanatory variables: AgeFAC, yearsIRFAC, FSFAC, Sex, RankCode, Ed and PE. Below is the description of both response and explanatory variables.

### **1. Response Variables Descriptions**

The response variable,  $y$ , in this study is an indicator variable for attrition. In this study,  $y$  is defined as 1 if an employee leaves DA in CY 2009 and 0 otherwise. We note that classifying separation by type can yield an attrition response variable with more than two levels. For example, the variable specifying retirement, termination, and resignation among those who leave in CY 2009 is three-level dependent variables. Retirement is a combination of people who left due to volunteer, special option, and disability retirement. Termination is a combination of people who left due to removal, resignation or retirement in lieu of involuntary action, regular termination, and termination during probationary

period. Resignation contains everybody else who left at the end of CY 2009 and we do not know why.

## **2. Explanatory Variables**

This data has three sets of explanatory variables: demographic, job, and compensation variables. Demographic variables in this data include age on 31 March 2009 and gender. Job variables in this data are years of credited federal service and retirement eligibility on 31 March 2009. Years of credited federal service includes prior military service served honorably, time in other federal agencies as well as time in DoD. This data contains 3,356 employees with prior service.

Retirement eligibility and separation options are determined using outlined guidelines in the Office of Personnel Management (OPM). There are three types of retirement eligibility categories: voluntary retirement, disability retirement, and special option retirement eligibility. Special option retirement falls under special separations authorizations exercised during drawdown period (OPM, n.d.).

### ***a. Voluntary Retirement Eligibility***

According to OPM, the minimum retirement age is 60 and 62 years with a minimum of 20 and 5 years of service respectively. An employee has to meet an age requirement that depend on their birth year in order to retire under Minimum Requirement Age (MRA) authorization with a minimum service of 30 years with no special requirements or a minimum of 10 years with their annuity reduced by 5 percent yearly until the employee reaches 62 years of age (OPM, n.d.). An employee's birth year determines MRA (OPM, n.d.). People born before 1948, have MRA 55. People born between 1948 and 1952, have MRA 55 increased by 2 months increment for each additional year. People born between 1953 and 1964, have MRA 56 (OPM, n.d.). People born between 1965 and 1969 have MRA 56 increased by 2 months increment for each additional year and finally for birthdays after 1970, MRA is 57(OPM, n.d.). This data shows that we have 153 employees who retired voluntary in CY 2009.

***b. Disability Voluntary Retirement***

An employee can only apply for disability retirement after he or she has provided their organization medical documents stating that they cannot perform their current duties and their organization cannot accommodate them or reassign them (OPM, n.d.). FERS annuity requirements for disability retirement eligibility is any age with 18 months service time (OPM, n.d.). Preliminary studies of our data shows that we have 29 employees who left by the end of 2009 under this category.

***c. Special Option Separations***

(1) Voluntary Early Retirement Authority (VERA)

VERA has a minimum age and service requirements of at least age 50 with 20 years' of "creditable federal service or any age with at least 25 years' creditable federal service" (OPM, n.d.). To qualify for VERA, "an employees must be currently working in VERA authorized position for at least 30 days and leave the organization during the authorized VERA period" (OPM, n.d.). Based on our data, there is 1 employee who left federal employment under VERA requirements during our observation period.

(2) Voluntary Separation Incentive Payments (VSIP)

An employee must be working continuously for at least three years in a position under the executive branch of the federal government (OPM, n.d.). The employee seeking VSIP eligibility must apply and receive approval from their agency if it is offering VSIP (OPM, n.d.). Our data contains 21 employees who fall under this category. Lack of UICs and duty location limits any expansive studies on these personnel. It is impossible to tell which organizations were authorized VSIP. It is also possible for organizations to choose which departments within the organization they will implement VSIP.

**C. SUMMARY STATISTICS FOR CY 2009 DA CIVILIAN DATA**

Table 2 shows summary statistics of CY 2009 DA civilian employee data, 53.87 percent are males. The average age of the employees is 46.74 with a range between 17.5 and 87.5 years. Our data also shows that we have an average of 12 years before retirement eligibility most employees are GS 1–9, and none are GS 14–15. Age is taken to be the age of the employee on 31 December 2009, it is approximated using the birth year, and month found in the master file quarterly snapshots. The age distribution is given in Figure 1.

Table 2. Demographics Summary Statistics CY 2009 DA Civilians

<b>Variables</b>		<b>Percentages</b>	<b>Range</b>	<b>Mean</b>
Sex:				
	Female	46.13		
	Male	53.87		
Years of Federal Service			17.5-87.5	46.74
Age			0.02-58.03	14.9
Rank Code:				
	GS 1-9	53.28		
	GS10-11	15.65		
	GS 12-13	24.21		
	GS 14-15	0		
	BAND	6.85		
Years to Immediate Retirement			0-37.5	12

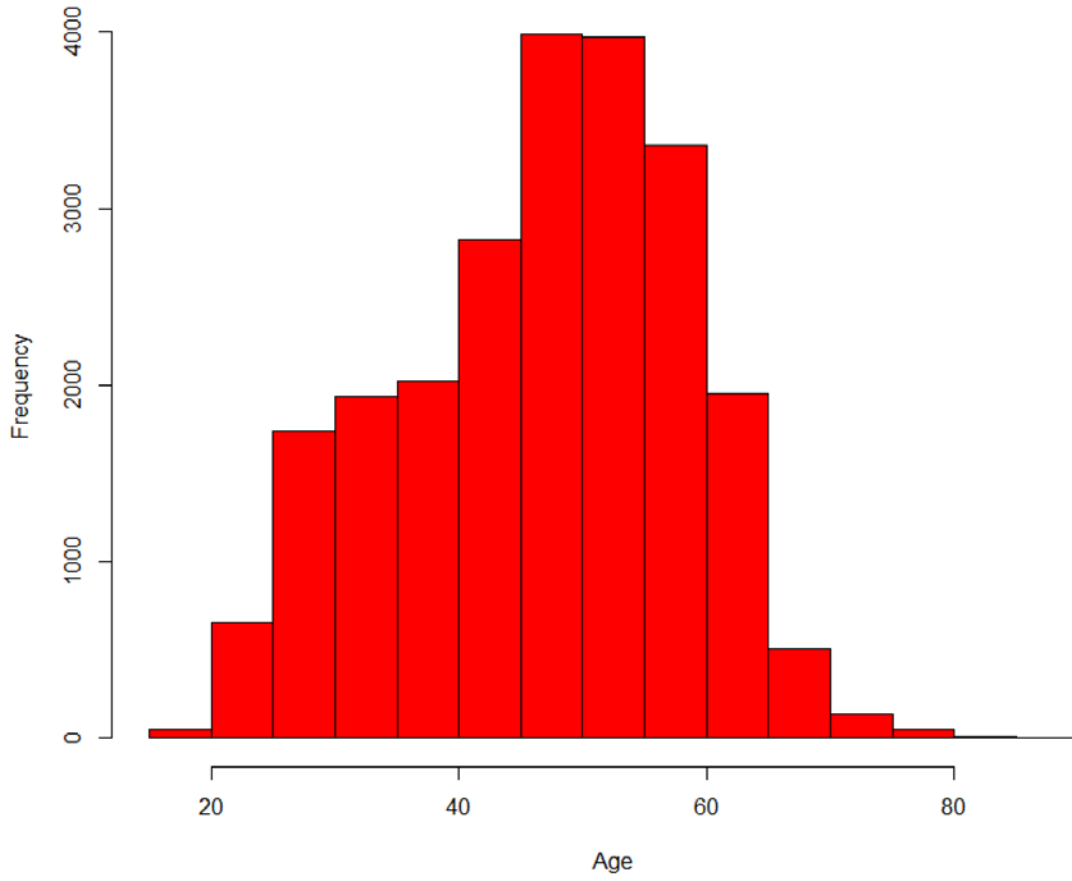


Figure 1. Histogram for Age Distribution

Years to immediate retirement is the minimum time required for an employee to retire given their age and FS. Figure 2 shows years to immediate retirement distribution.

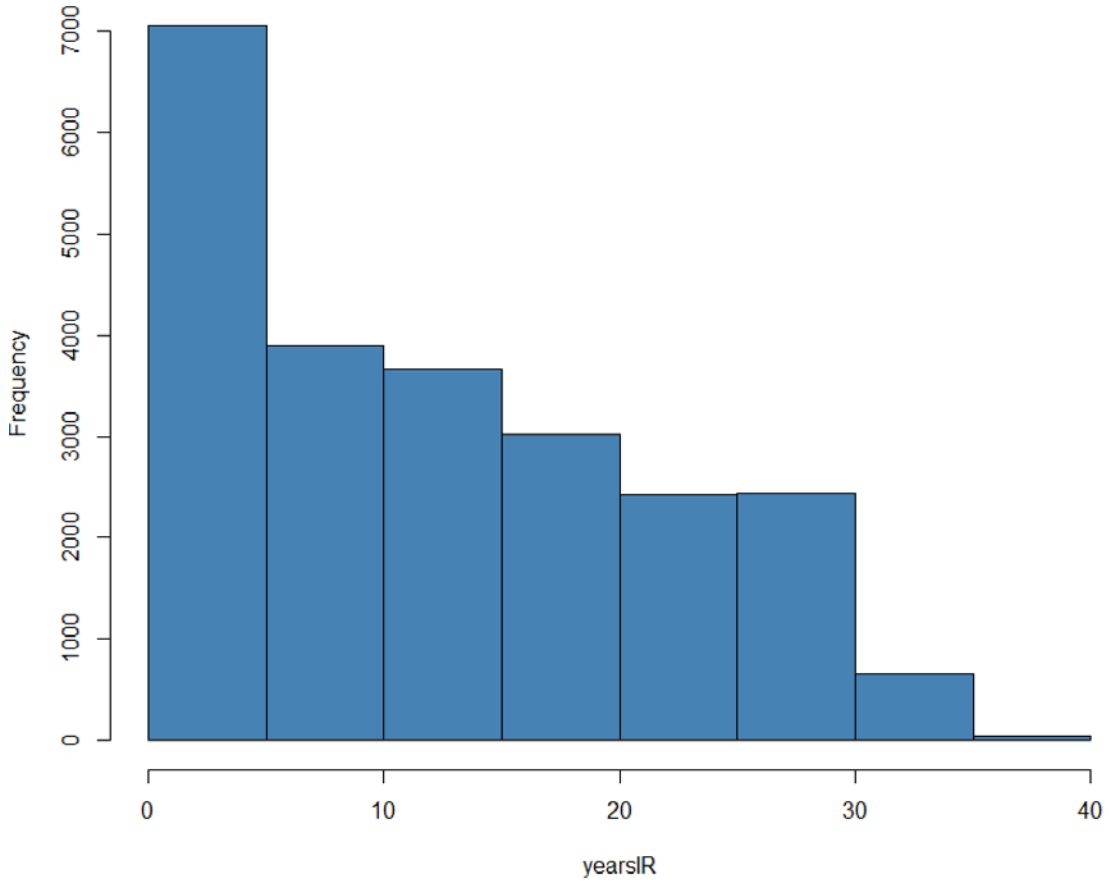


Figure 2. Histogram for Years to Immediate Retirement Distribution

FS is the difference between 2009-12-30 and the recorded date that an employee joined the federal service in the first transaction or first file. Figure 3 shows FS distribution.

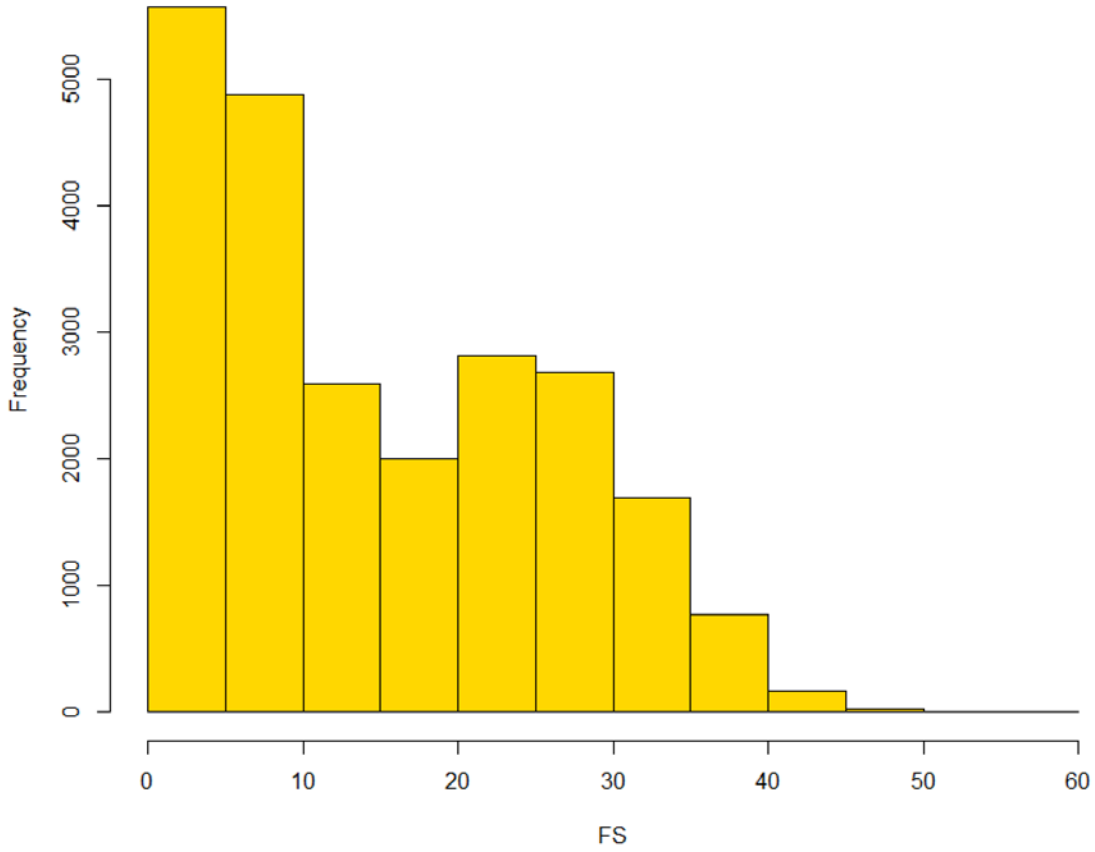


Figure 3. Histogram for Credited Federal Service Distribution

#### **D. DATA LIMITATIONS**

The goal for this study is to identify factors affecting attrition concentrating mainly on retirement. Studies have shown that retirement eligibility does not mean that these employees will retire. There are other factors that affect decision to retire. An example of these factors are economy as a whole, locality, health insurance, dependents, and job position. DMDC data lacks some useful variables such as full ZIP codes, number of dependents and marital status data, and finally health care insurance enrollments, UICs and billet codes that could help us predict human behavior in retirement trends. For example, a person not enrolled in health care insurance may be a second income earner with an increased probability of leaving a job. Locality might also help identify organizational systematic issues or highlight opportunity cost by comparing job opportunities between federal employment and local economy. BAND ranking system did not identify levels employees in our data belonged making it difficult to compare with GS ranking system.

#### **E. SUMMARY**

This chapter covers CY 2009 DA civilian data provided in the PDE. It provides preliminary statistics that help build both logistic regression model in Chapter IV.

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## IV. RESULTS

This chapter discusses the logistic regression model fit to the sample of civilian employed by DA in the first quarter of CY 2009. The model estimates the probability of attrition of attrition in CY 2009.

### A. LOGISTIC REGRESSION MODEL

We start by fitting logistic regression model with seven categorical explanatory variables ageFAC, yearsIRFAC, FSFAC, Sex, Ed, RankCode and PE described in Chapter III. Because the sample size 23,197 is so large, we expect formal hypothesis testing to yield statistical significance even when there is no practical difference in the null hypothesis and alternative hypothesis fits. To check for practical differences, we randomly select 20% of the records to serve as a test or validation set. The 80% remaining training I the set used to fit models.

The first logistic regression model fit is additive. It contains no interactions among explanatory variables. The second model fit includes all possible interaction terms. A large sample Likelihood Ratio Test (LRT) rejects the null hypothesis of the additive model in favor of the model with two-way interactions with a p-value  $< 0.0001$ . However to check the practical difference differences between the additive model and the one with interactions, we compute and plot Receiver Operating Characteristic (ROC) curves for both models using the 20 percent validation set. We use this validation set rather than the original training set to compensate for potential overfitting by the large model with two-way interactions. Figure 4 shows the validation set ROC curves for additive model (green) and the model with interactions (red). The ROC curve for the additive is a bit below that of the model with interactions, but there is very little difference in the two curves. This suggests that for practical purposes, for this data, the additive model suffices.

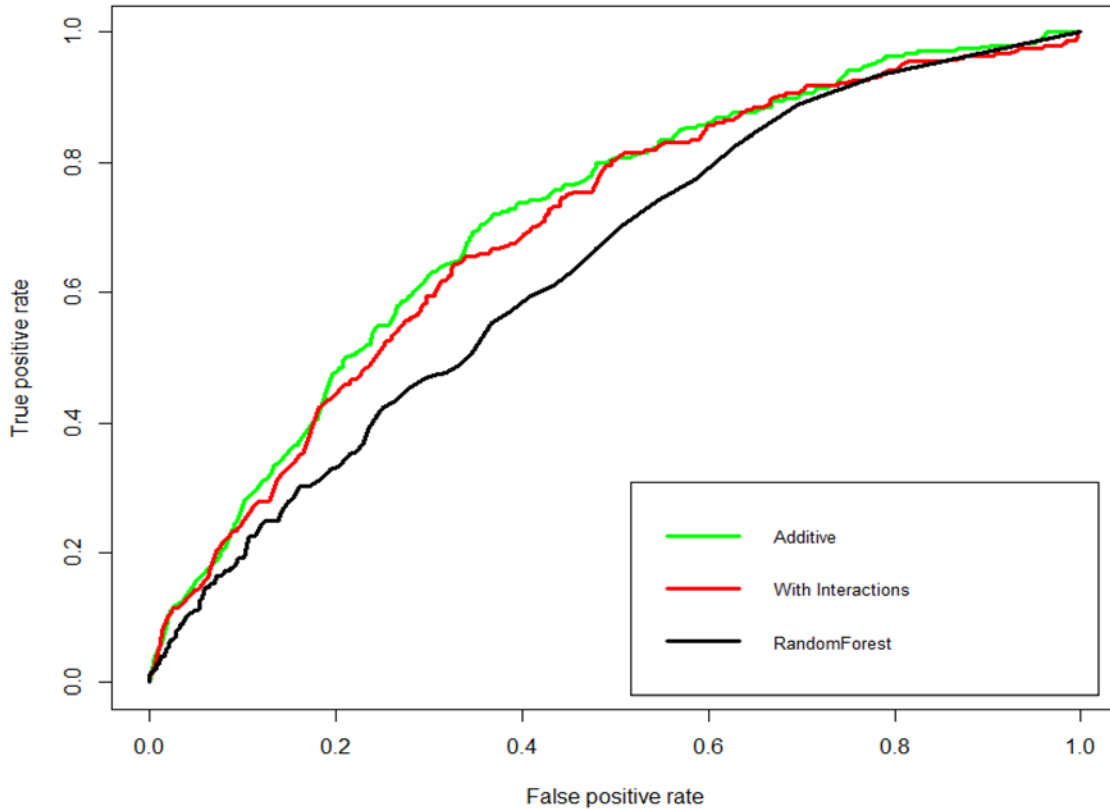


Figure 4. ROC Curves for Additive, Interaction and Random Forests Models

We then use backwards elimination to eliminate, in order, the explanatory variables prior service (PE), RankCode and Sex. This leaves a logistic regression model with four categorical explanatory variables ageFAC, FSFAC, yearsIRFAC and Ed.

In addition, as a separate model fitting check, we fit random forests (Breiman, 2001) using the numeric versions of the explanatory variables rather than categorical ones. Random forests are non-parametric models that do not presume a functional form for numeric explanatory variables, automatically include interactions if present and are robust to extreme values. The random forests ROC curve (black) evaluated on the validation set shown in Fig 4, does not perform as well as the logistic regression model. This further supports our additive model fit and how we chose to construct categorical versions of numeric variables.

## B. FINAL MODEL FIT

The structural part of a logistic regression model is usually written in terms of the log-odds of  $\log\left(\frac{p}{1-p}\right)$  where for our model,  $p$  is the probability of attrition. The final model from the previous section is:

$$\log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_{A1}x_{A1} + \dots + \beta_{A7}x_{A7} + \beta_{Y1}x_{Y1} + \beta_{Y2}x_{Y2} + \beta_{Y3}x_{Y3} \\ + \beta_{FS1}x_{FS1} + \dots + \beta_{FS4}x_{FS4} + \beta_{E1}x_{E1} + \beta_{E2}x_{E2} + \beta_{E3}x_{E3} \quad ,$$

where  $\beta_0, \dots, \beta_{E3}$  are coefficients to be estimated and  $x_{A1}, \dots, x_{A7}$  are binary variables taking value 1 if ageFAC is (20, 25], ..., (60, 90] respectively and 0 otherwise:  $x_{Y1}, x_{Y2}, x_{Y3}$  are the binary variables taking the value 1 if yearsIRFAC is (1,5], (5,10], (10,40] respectively and 0 otherwise;  $x_{FS1}, \dots, x_{FS4}$  are the binary variables taking the value 1 if FSFAC is (5,10], ..., (25,60] respectively and 0 otherwise.  $x_{E1}, x_{E2}, x_{E3}$ , are binary variables that take value 1 if Ed is high school, a four year college degree, a master's degree or higher respectively and zero otherwise.

For each categorical variable, one level, the reference level, has a coefficient of zero and is left out of the logistic regression model. The reference levels are (17, 20], [0, 1], [0, 5] and no high school for ageFAC, yearsIRFAC, FSFAC, and Ed respectively. Table 3 gives the estimated coefficients and estimated p-values for the large sample Wald test that the corresponding coefficient is zero.

Table 3. Attrition Model Coefficients

	<b>Estimate</b>	<b>Standard .Error</b>	<b>Z Value</b>	<b>P value</b>
Intercept	-0.08	0.49	-0.169	0.865
AgeFAC(20,25]	-0.54	0.34	-0.157	0.115
AgeFAC(25,30]	-1.45	0.34	-4.199	0.000
AgeFAC(30,35]	-1.48	0.35	-4.269	0.000
AgeFAC(35,40]	-1.92	0.36	-5.400	0.000
AgeFAC(40,45]	-1.91	0.35	-5.461	0.000
AgeFAC(45,50]	-2.24	0.35	-6.318	0.000
AgeFAC(50,55]	-2.03	0.38	-5.289	0.000
AgeFAC(55,60]	-1.04	0.42	-2.707	0.007
AgeFAC(60,90]	-0.64	0.44	-1.468	0.142
YearsIRFAC(1,5]	-1.04	0.17	-6.100	0.000
YearsIRFAC(5,10]	-0.76	0.25	-3.074	0.002
YearsIRFAC(10,40]	-0.24	0.34	-0.724	0.469
FSFAC(5,10]	-0.64	0.10	-6.198	0.000
FSFAC(10,15]	-0.59	0.13	-4.435	0.000
FSFAC(15,25]	-0.95	0.14	-6.875	0.000
FSFAC(25,60]	-0.74	0.16	-4.704	0.000
Ed1	-.036	0.21	-1.688	0.091
Ed2	-0.72	0.22	-3.252	0.001
Ed3	-0.74	0.24	-3.066	0.002

The overall attrition is 5.5 percent so the estimated probabilities are all very small, hence the estimate coefficients of the model are negative. Negative coefficients give negative estimated log odds, which explains estimated probabilities close to zero. For example, using this model, we can estimate the probability of attrition for a 25 year old with four years of federal service and a high school education. The estimated log odds for this individual is -0.863. In addition, the estimated probability of attrition for an individual of this type is 0.30. We can also derive a 95 percent confidence interval (CI) for the probability of attrition. The standard error for the estimated log-odds is 0.23 giving an approximate of 95% for the probability of [0.21, 0.39].

All else held constant, the probability of attrition is highest for 18 year olds. As age increases, probability of attrition goes down until the age of 50 and then it increases until the end. Probability of someone to attrite when they have one to five years to retire is lower than when an employee has more time left before they are eligible to retire. Employees with low credited federal service time have a higher attrition rate. Attrition rate then slows down between the 10 to 15 years, spikes at 15 to 25 years and then decreases at 25 to 60 years of credited federal service time. Our model shows that employees with an education level of Bachelors or Masters are less likely to attrite compared with those with high school and no high school diplomas.

We also use this model to estimate the probability of attrition for DA civilians as a function of age for age for different numbers of years of credited federal service (FS) and education levels. We note that the variable yearsIR and the categorical versions of yearsIRFAC are functions of age and FS. Table 4 gives the levels of years IRFAC corresponding to FS= 0 and the ages given in the Table 4. For completeness, we also show the levels of ageFAC and FSFAC.

Table 4. Explanatory Variables for Employees without Credited Federal Service

<b>Age</b>	<b>ageFAC</b>	<b>yearsIRFAC</b>	<b>FSFAC</b>
20	(17, 20]	(25,30]	[0,5]
25	(20,25]	(20,25]	[0,5]
30	(25,30]	(15,20]	[0,5]
35	(30,35]	(15,20]	[0,5]
40	(35,40]	(15,20]	[0,5]
45	(40,45]	(10,15]	[0,5]
50	(45,50]	(10,15]	[0,5]
55	(50,55]	(5,10]	[0,5]
60	(55,60]	(1,5]	[0,5]
65	(60,90]	(1,5]	[0,5]

Figure 5 shows the estimated probability of attrition with a 95 percent confidence intervals of DA civilians with an explanatory variable values given in Table 4 and no high school education.

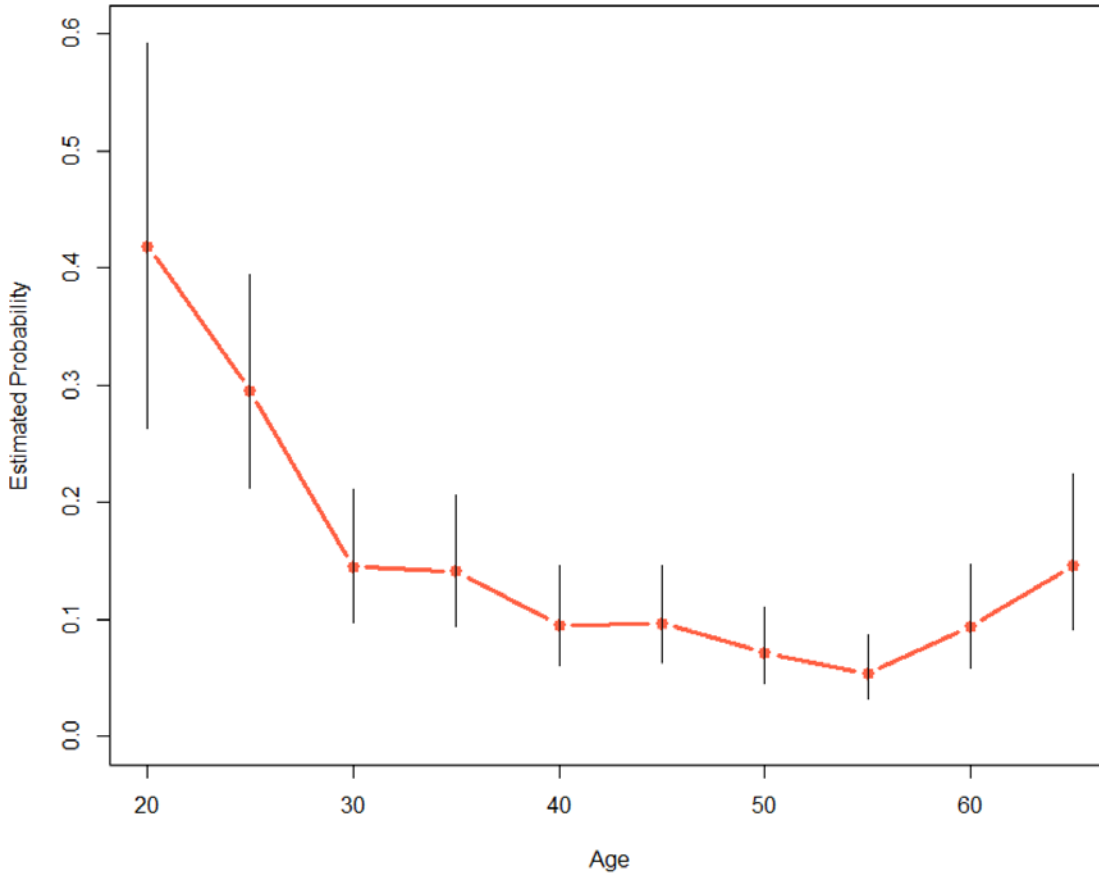


Figure 5. Estimated Probability of Attrition for DA Civilians with 95% Confidence Intervals for FS=0 and No High School Education as a Function of Age

Table 5 shows an explanatory variable for DA civilian employees with 10 years of FS as a function of age. Our age range is between 27 to 65 years of age given that the youngest employee in our data is 17 years old. Figure 6 shows estimated probability of DA employees with 10 years of FS and no high school diploma given age. Our study shows that with 10 years FS, the probability to attrite is approximate 0.08 between 27 and 35 years of age, then steadily decreases between the ages 35 and 60, and then spikes to approximately to a probability 0.15 between 60 and 65 years of age.

Table 5. Explanatory Variable Values for Employees with 10 Years' Credited Federal Service

<b>Age</b>	<b>ageFAC</b>	<b>yearsIRFAC</b>	<b>FSFAC</b>
27	(25,30]	(25,30]	(10,40]
35	(30,35]	(20,25]	(10,40]
40	(35,40]	(20,25]	(10,40]
45	(40,45]	(10,15]	(10,40]
50	(45,50]	(5,10]	(10,40]
55	(50,55]	(5,10]	(10,40]
60	(55,60]	(1,5]	(10,40]
65	(60,90]	[0,1]	(10,40]

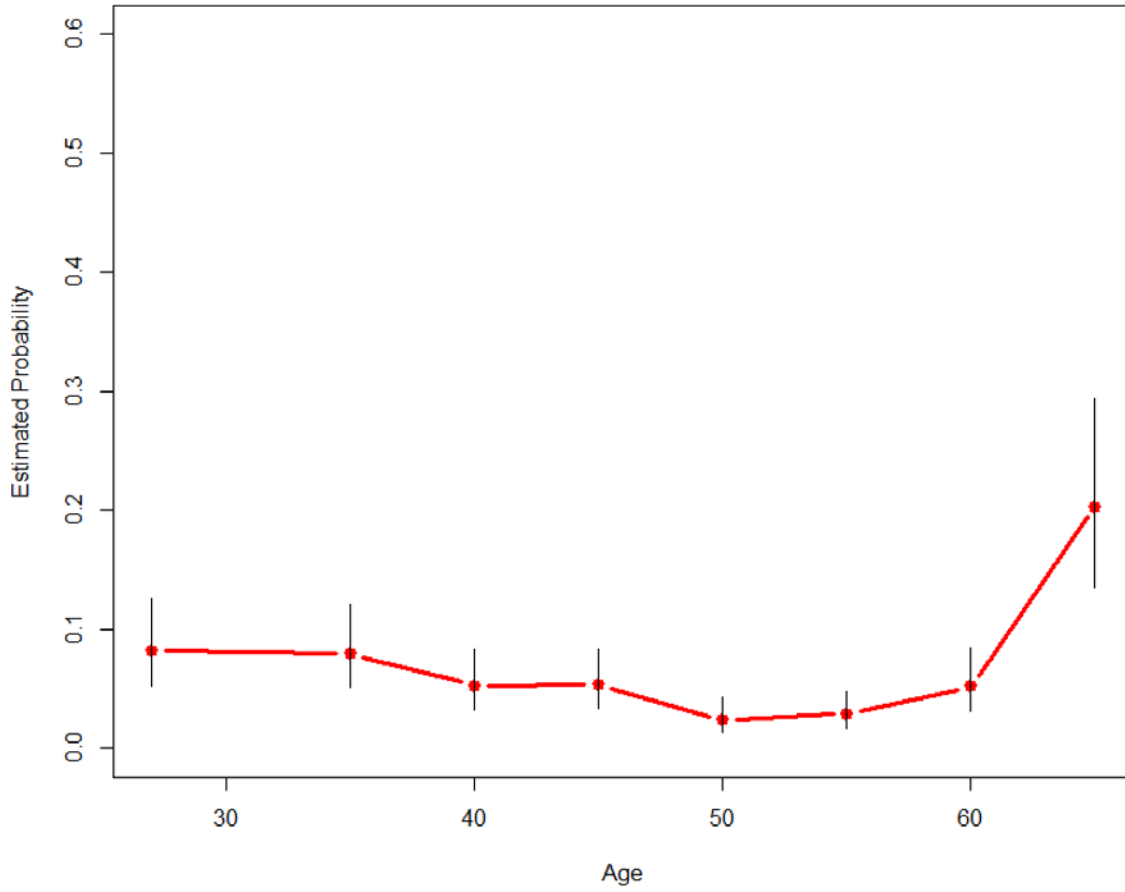


Figure 6. Estimated Probability of Attrition for DA Civilians with 95% Confidence Intervals for FS=10 and High School Education as a Function of Age

Table 6 gives variables values of employees with 20 years FS. The age range is between 37 to 65 years of age given that the youngest employee in our data is 17 years old.

Table 6. Explanatory Variables Values for Employees with 20 Years' Credited Federal Service

<b>Age</b>	<b>AgeFAC</b>	<b>YearsIRFAC</b>	<b>FSFAC</b>
37	(35,40]	(15,20]	(10,40]
40	(35,40]	(10,15]	(10,40]
45	(40,45]	(10,15]	(10,40]
50	(45,50]	(5,10]	(10,40]
55	(50,55]	(5,10]	(10,40]
60	(55,60]	(1,5]	(10,40]
65	(60,90]	[0,1]	(10,40]

Figure 7 shows estimated probability of attrition for DA civilian employees without a high school diploma to leave after 20 years of federal service. The estimated probability to leave is approximately 0.05 and remains stable between 37 to 45 years of age then it gradually decreases between 45 to 55, a slight increase between 55 to 60 before a steep increase between the age of 60 to 65.

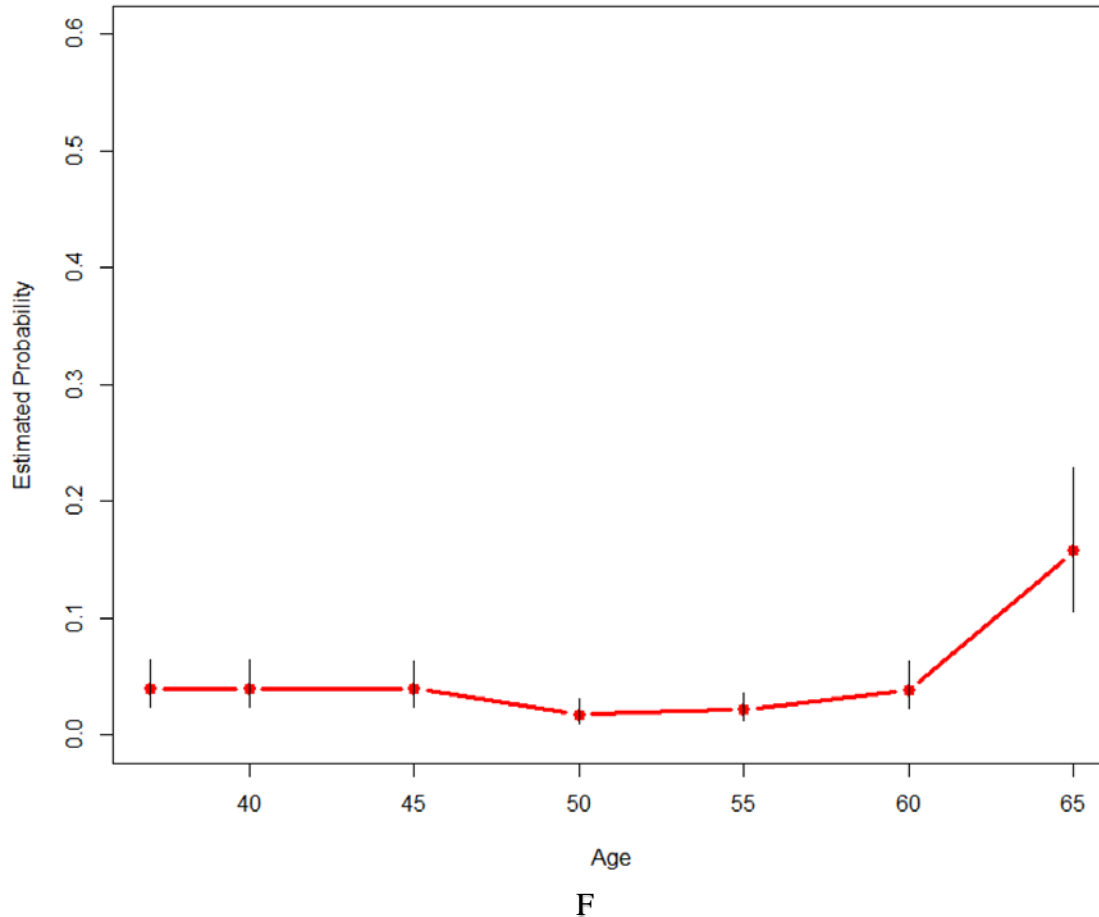


Figure 7. Estimated Probability of Attrition for DA Civilians with 95% Confidence Intervals for FS=20 and No High School Education as a Function of Age

Figure 8 compares DA civilian employee estimated probability of attrition as a function of age for varying FS and education levels 1,2,3 corresponding to high school, four year degree, master's degree or higher.

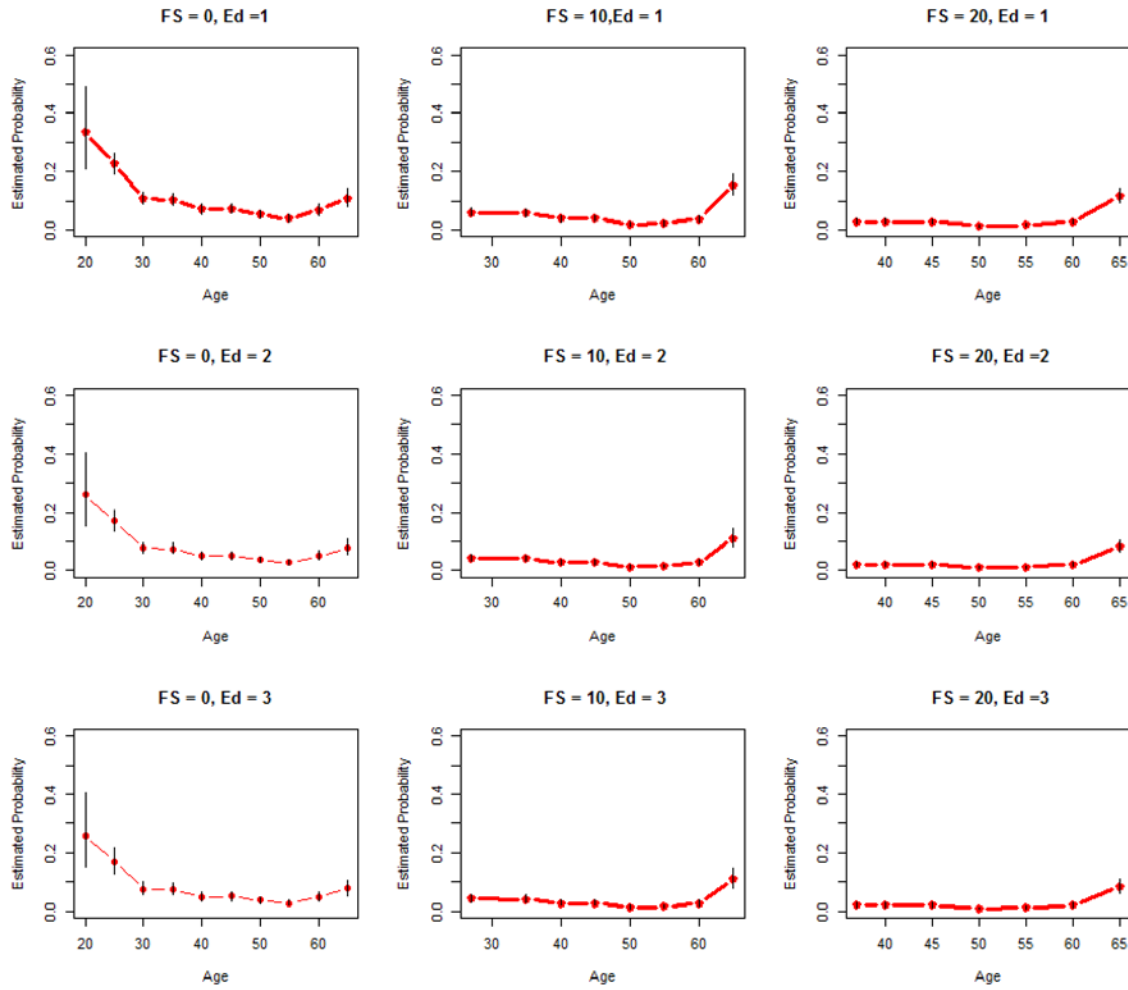


Figure 8. Estimated Probabilities of Attrition for FS = 0,10, 20 (Columns) and Ed = 1, 2, 3 (Rows)

FS = 0, Ed = 1 graph in Figure 8 shows estimated probability of attrition for DA civilian employees without FS, but have a high school diploma. We have a higher estimated probability of attrition among the 17 olds at approximately 0.32, and then declines sharply among the 20 to 30 year olds at 0.1. We then see a steady estimated probability decline among 30 to 55 year olds. Finally, we see a steady increase in estimated probability from 55 to 65 year olds. FS = 0, Ed = 2 follows the same pattern as FS= 0, Ed = 1 except the estimated probability of attrition drops by approximately 0.04 points throughout. There is no significant difference in estimated probability for attrition for FS =0, Ed = 3 and FS=0, Ed =2.

Employees with FS = 10 estimated probability of attrition is lower than that of an employee with FS = 0. FS = 10, Ed = 1 graph on Figure 8 shows the estimated probability of DA employee with 10 years FS and a high school diploma to attrite. Estimated probability of attrition between 27 and 35 is stable at approximately 0.08. However, the estimated probability lowers from approximately 0.08 to approximately 0.06 at age 40 and gradually declines until age 50, and then it starts increasing with a peak of a little over 0.1 at 65. FS =10, Ed = 2 and FS =10, Ed =3 follows similar pattern as FS =10, Ed = 1 except that the estimated probabilities of attrition are slightly lower but not significant than FS =10, Ed =1.

FS= 20, Ed =1, 2, 3 graphs show significantly low estimated probability of attrition among 37 and 60 year olds with FS = 20 at approximately 0.0002. Estimated probability of attrition then increases after 60 years of age to 0.1.

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## **V. CONCLUSION**

This chapter summarizes the use of logistic regression model to analyze the attrition of DA civilian data in CY 2009. We made conclusions and recommendations based on the results described in Chapter IV.

### **A. LOGISTIC REGRESSION MODEL CONCLUSION**

The logistic regression model showed a 5.5 percent attrition rate. Attrition based on age is as expected with younger and older employees leaving at a higher rate than the middle age group. It also shows that estimated probability of employees without high school education to leave federal workforce is always higher than that of an employee with a high school diploma and some college education. We also see that employees with 10 years and more of FS have a lower probability to attrite between the ages 40 to 60.

### **B. RECOMMENDATIONS**

- (1) Expand research to include the year before and a couple of years after CY 2009

In 2008, the U.S. suffered a recession. Poor economy would deter more people from retiring especially if their 401 Ks were tied to investments. Although we had more resignations than retirements from our data, the U.S. Army was conducting drawdowns causing employees to feel as if the future of their jobs was unstable therefore making a decision to leave for more stability.

- (2) Allow use of PII

Lack of PII restricted the scope of research. For example, we were not able to identify organizational systematic issues due to scrambled UICs and ZIPs. Other PIIs such as number of dependents, health and life insurance enrollment are all indicators of whether an employee is a second income earner, which allow them to leave. In addition, UICs would allow the researcher to identify if we are losing employees to other federal agencies in the area.

(3) Allow appointment dates for current positions

Appointment dates would allow us to see how long it takes the employee to progress in their career. Lack of progress could be an indicator for attrition.

(4) Updated last transaction details

40.8 percent of employees who separated last transaction detail does not state reason for separation. Availability of this information would help us in the future look at differences between retirement, resignations and removal for cause.

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