Department of Defense Retirement

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[1] This article was completed under a Cooperative Research and Development Agreement with the US Air Force Academy. We would like to thank Scott Seggerman, Andrew Smith and Vanessa Johnson from the Defense Manpower Data Center. We could not have conducted this research without their support providing us with the data.

Abstract

Using data on officers and enlisted members of the United States military from 1981 through 2011, we analyze the effects of future retirement benefit eligibility upon the decision of whether to remain in the military to quality for retirement benefits upon completing 20 years of active duty service. We find that the generosity of retirement benefits is strongly correlated with the decision to qualify for benefits, even given the large discount rates found in previous work.

Introduction

In an era of tightening defense budgets, annual expenditures required to maintain the military retirement system in its current form are forecast to increase from $52.2 billion in fiscal year 2011 to $116.9 billion in fiscal year 2035. (Office of the Actuary, 2012) According to the Defense Business Board[2], "Whereas average private sector pension contributions range from 4 to 12 percent per year, military retirement benefits equate to an approximate contribution of 75 percent of annual pay per year." (Defense Business Board, 2011) Alarm about the sustainability of this system is not new. House Armed Services Committee Chair, later Secretary of Defense, Les Aspin, described the system as "a time bomb … ready to go off." Notably, Representative Aspin later championed the one substantial change to the military retirement system (The Military Retirement Reform Act of 1986) which President Reagan signed into law July 1st, 1986. This reduction in benefits would last until the fiscal year 2000 National Defense Authorization Act repealed "REDUX", then giving members the choice of the previous military retirement. Most notably, though, the discussion surrounding military retirement seems to ebb and flow with the strength of the civilian job market, the level of U.S. involvement in conflicts overseas, and the fiscal climate in the United States.

Given the "fiscal cliff" the United States is rapidly approaching, we are not surprised that the subject of military pensions is moving front and center once again. According to Blue Star Families, an advocacy group for military families which conducts an annual survey of military

[2] The Defense Business Board (DBB) is established under the authority of the Secretary of Defense, under the provision of the Federal Advisory Committee Act (FACA) of 1972, with the charter to provide "…independent advice and recommendations on critical matters concerning the Department of Defense…" http://dbb.defense.gov/charters.html The DBB is an independent group of 19 leading business persons with voting authority and four government observers

families, 31% of respondents (4,000 military families) list a change in retirement benefits as their number one concern.[3] Much of this concern may stem from a proposal put forward by the Defense Business Board (DBB) which recommends major changes to the military retirement system. This recommendation represents a radical departure from the current military pension system, but one that is more comparable with private sector pension systems and addresses funding shortfalls as well as some perceived inequities in the system.

Under the current system of military pensions, a member of the military must serve a minimum of 20 years to secure a pension. To investigate the effect of pension eligibility on the decision to remain in the military, we use an option value framework (Stock and Wise, 1990) to compare the utility of remaining in the military and qualifying for a pension versus joining the civilian workforce and forfeiting pension eligibility. Asch *et al* (2005) uses this approach to study the effects of the federal civilian retirement system. We extend the military retirement literature by utilizing a survival analysis framework and analyzing the retirement decisions of officers as well as enlisted members of the military. Prior research (Asch and Warner (1994), Asch *et al.* (1998) Asch *et al.* (2008), Ausink and Wise (1996), and others) either focuses solely on enlisted members of the military or they examine a smaller subset of the officer corps, namely pilots. Our results show that current retirement benefits do substantially affect the decision of whether to remain in the military long enough to quality for retirement benefits. Given the substantial discount rates of military members found by Warner and Pleeter (2001), it could be financially advantageous for the Department of Defense to redirect funds from

[3] This is the third annual release of the Blue Star Families survey; however, in 2009 and 2010, the survey did not list retirement benefits/changes as an option. Given this is the first survey that includes retirement pay as a separate category, it is difficult to know how this concern has changed over time. Survey results downloaded 5/22/2012 from: http://bluestarfam.s3.amazonaws.com/42/65/a/1110/CompReport2012.pdf

retirement benefits to current compensation, but a thorough investigation of this is beyond the scope of our paper.

Our paper proceeds as follows: We begin with a review of the military retirement systems of the United States, Canada, and the United Kingdom, present the theoretical framework of our model, describe our data, present our results, and conclude.

Military Retirement Systems

The military retirement system has seen minimal changes since the passage of the Army and Air Force Vitalization Act of 1948, which standardized the retirement system across all services. For all members who entered the service before September 1980, their projected military retirement benefit was half of final pay[4] while on active duty if the member stayed until they reached 20 years of service[5]. For each year of additional service past 20, an additional 2.5% is added to the benefit. Retirement payments are generally indexed for inflation, with the CPI index (now the CPI-W) the measure of an increase in the cost of living. For members who enter after September of 1980 but before the passage of Public Law 99-348 (most commonly known as REDUX) in July of 1986, an average of the last three years of pay is used versus pay in their final year.

[4] Final pay is defined as taxable military compensation. Regular military compensation, which is most comparable to civilian salaries, includes allowances, which in some instances might be large, and tax benefits associated with these allowances (Office of the Actuary, 2012). For instance, members receive allowances for housing and for subsistence; these do not, however, factor into retired pay calculations. From the Office of the Actuary (2012), base pay represents about 69 percent of regular military compensation for all retirement eligible members and 67.3 percent for 20-year retirees; thus, a retiree at 20 years would receive about 33.7 percent of regular military compensation.

[5] The military retirement system includes individuals who served for at least 20 years on active duty and chose to retire, individuals who retired early due to disability, and individuals who served in the reserves and satisfied the reserve criteria for retirement, of which the biggest difference is that reservists must wait until they reach 60 years of age to begin drawing retirement.

For members who entered between July 1986 and the subsequent repeal of REDUX in 2000, the computation is more complex. Members initially were entitled to 40% of their highest three years of military pay at 20 years of service. For each year that a member stays past 20, they would earn an additional 3.5% versus the 2.5% under the previous plan. Thus, a member who stays 30 years under REDUX would almost have the same retirement benefit as one who retired before REDUX. Under REDUX, members also received a 1% reduction in their cost of living increase until age 62. At age 62, there is a one-time catch-up in the retirement pay amount; for each year after age 62, a member covered under REDUX would continue to receive a cost of living increase as measured by the CPI less 1%. The National Defense Authorization Act for Fiscal Year 2000 repealed the mandatory provision of REDUX. After its repeal, members could opt to take REDUX upon reaching 15 years of service; to make this option more attractive, members received a one-time taxable payment of $30,000.

Table 1
Comparison of three U.S. military retirement systems

	Final Pay	High Three	REDUX
Base Pay Amount	Final base pay, excluding bonuses	Average base pay in highest 36 months, excluding bonuses	Average base pay in highest 36 months, excluding bonuses
Percentage of Base Pay Amount received in retirement	50% + 2.5%*(years of service – 20)	50% + 2.5%*(years of service – 20)	Before age 62, 40% + 3.5%*(years of service – 20); Beginning age 62, 50% + 2.5%*(years of service – 20)
Cost-of-living adjustment	Base Pay Amount increases with CPI inflation rate	Base Pay Amount increases with CPI inflation rate	Before age 62, Base Pay Amount increases with CPI inflation rate less 1%; at age 62, Base Pay Amount is adjusted to amount under High Three; after age 62, this adjusted Base Pay Amount increases with CPI inflation rate less 1%

Table reproduced from Jennings and Reichenstein (2001) with permission of authors

The American system of vesting after 20 years of service stands in contrast to that of some major military allies. In Canada, the current formula is: (1.375% x total pensionable service x average earnings up to the average yearly maximum pensionable earnings[6] (YMPE))+(2% x total pensionable service x average earnings over average YMPE), where YMPE = maximum amount of earnings the Canadian government sets each year and uses to calculate contributions and pensions under the Canadian Pension Plan/Quebec Pension Plan (CPP/QPP).

[6] For 2012, this is $50,100. This is equivalent to the maximum amount of U.S. earnings available for Social Security contributions. For comparison purposes, a major in the Canadian Armed Forces earns between $100,000 and $110,000 (CAD). A major in the U.S. military earns between $77,000 and $86,000 in base pay, plus an average of $20,000 a year in allowances to pay for housing and subsistence. A Canadian sergeant earns between $64,000 and $78,000, while a U.S. E-7 earns between $46,000 and $58,000 in base pay, plus an average of $18,000 additional allowance for housing.

Average earnings are computed over the five highest consecutive years of service. Finally, pensionable service includes the period of service when the member contributes to the Regular Force Pension Plan. Over the last five years, the average contribution paid by Canadian members is 5.8% on amounts up to the YMPE and 8.4% for any amount greater than the YMPE. Members who retire before 65 years of age receive a bridge benefit paid until age 65 (at which time, either the CPP or QPP begins) of 0.625% x total pensionable service x YMPE. The CPP/QPP is the Canadian or Quebec equivalent of the United States Social Security system, although the rates of taxation are lower, as is the benefit payment. Benefits are indexed for inflation, but noteworthy is the fact that the plan is the same for federal workers or Canadian federal government workers.

In the United Kingdom, there are two governing pension systems for military members, the Armed Forces Pension Scheme (AFPS) 75 and AFPS 05[7]. Members who join before April 6, 2005 are covered by AFPS 75 and those who join after are covered by AFPS 05. Members covered by AFPS 75 do not collect full retirement unless they retire at the age of 55 or later. If they retire before age 55, and they have either 16 years (officers) or 22 years (others), they qualify for an immediate pension which pays 28.5% and 32%, respectively, as compared to the maximum pension amount of 48.5%. Both the immediate pension and the full pension also pay a one-time lump sum amount equal to 3 times the annual pension amount. Interestingly, U.K. members below the rank of 1-star general who belong to AFPS 75 receive representative pay, which means they receive the pay representative of someone who has served for the specific number of years and achieved that specific rank. Members who don't serve enough years to

[7] The following information comes from pamphlets published by the U.K. Service Personnel and Veteran's Agency.

earn the immediate pension may be entitled to a preserved pension, which pays a much lower amount, as well as the lump sum benefit of 3 times annual pay, at age 65. This pension is not indexed for inflation.

The AFPS 05 scheme is more complicated. The benefits are based on final pensionable pay, not representative pay. AFPS 05 members who leave before age 55 will also earn a preserved pension with the same benefits as the AFPS 75. If a member retires on or after age 55, she will receive an immediate pension equal to years of reckonable service x (1/70) x final pensionable pay, where her final pensionable pay equals her highest 365 consecutive earning days from the last three years. This pension amount is indexed for increases in cost of living. If she leaves before reaching 55, but she has reached 40 and served at least 18 years, then she gets early departure payments (EDP) until she reaches age 65. The level of EDP is beyond the scope of this paper, but suffice it to say that it serves to accomplish the same goal as the bridge payment for Canadian pensioners who retire early. Table 2 provides a simplified comparison for the most likely pension scenario.

Table 2
Comparison of Military Pension Systems

	U.S. post-REDUX	Canada	U.K. AFPS 75	U.K. AFPS 05
Base Pay Amount	Average of last 36 months (no allowances)	Average of 5 highest paid consecutive years (no allowances)	Representative pay – e.g. all majors with 22 years of svs have same base pay amount (no allowances)	Final basic pay without allowances
Percentage of Base Pay Amount received in retirement	50% + (2.5%*(years of service – 20))	1.6875%*years of service * average pensionable earnings	48.5% annually + (lump sum = 3*annual pension amount)	Years of service *(1/70)*final pensionable pay + (lump sum = 3*annual pension amount)
Cost-of-living adjustment	Base Pay Amount increases with CPI inflation rate	Full increase associated with CPI inflation rates	No	Full increase associated with RPI (retail price index) inflation rates
Age Pension Eligible	After 20 years of service	55	55	55
Partial Pension Payments	None	Yes	Yes	Yes
Member Contributes	No	7.1%	No	No

Assumes Canadian member makes no extra contributions; also assumes Canadian and U.K. troops stay in to age 55; Canadian member contribution based on Canadian Major and Canadian Sergeant contributions over last five years

Table 2 illustrates the generosity of American military pensions relative to Canada and the United Kingdom in that a person who enlists at age 17 can begin drawing 50% of their base pay at age 37. In FY11, the average age of retirement for enlisted service members was 41.3 years of age, after 22.8 years of service; for officers, the average age is 45.2 years after 24.1 years of service (Office of Actuary, 2012)[8]. These numbers are virtually unchanged from a 1984

[8] FY11 numbers represent non-disability retirees excluding reserve retired.

study conducted by the Congressional Budget Office. For retirees in FY11, both officer and enlisted are expected to draw retirement pay for 38 years.[9] Using the average retirement age from FY11, U.S. enlisted members and officers earn retirement pay for more years (13 and 9 respectively) than their Canadian and U.K. counterparts; additionally, 22 years of service would equal 55% of base pay for enlisted troops, while 25 years of service would equal 62.5% of base pay for officers.

The other major difference is the possibility of receiving partial pension payments. Both Canada and the United Kingdom offer the possibility of partial retirement benefits. The United Kingdom offers benefits after just two years of "reckonable service" (MMP/106, 2008 and MMP/124, 2007), while Canada offers the possibility of a deferred annuity at age 60 for members who have just two years of pensionable service. This stands in stark contrast to the United States. Currently, military members do not receive any retirement benefits unless they serve 20 years. Military members who involuntarily separate typically receive involuntary separation pay; however, a member who chooses to leave on their own prior to reaching the requisite number of years of service does not receive any pension benefit. One caveat, though, is that military members are currently allowed to contribute pre-tax, non-DOD matched dollars to a 401-K plan, known as the Thrift Savings Plan (TSP), which heretofore was only open to Federal civilian employees. This option was established with the passage of the defense bill in FY2001.

There is evidence that military members are concerned about the lack of pension benefits before reaching 20 years of service. A 2008 TSP survey found that the average plan

[9] 38 years is based on male mortality rates. For females who retire at the average retirement age, they will receive retirement pay for 41 years, on average.

participant contributed 11.8% of their base pay, or an average annual contribution of $8,824 (Watson Wyatt, 2008). A separate study conducted by the Defense Manpower Data Center (DMDC) reported an average contribution rate of 6.1% (DMDC Report # 2009-002, 2009). Ninety five percent of the respondents stated the reason for participating was to save more money. While this may seem obvious, 10% responded they participated because they were advised to by their career counselor, and 10% responded they participated because they were advised to participate by their commander. A more recent survey of approximately 19,000 active duty members revealed that 46% of DOD respondents were currently participating in the TSP program; however, this number is skewed upward as the Navy's participation rate on this survey is 65%, with no other branch of service exceeding 44% (DMDC Report # 2011 – 001, 2012).

This same survey revealed that military members generally understand the apparent generosity of their retirement benefits, even as many of them fail to serve long enough to earn this benefit (DMDC Report # 2011 – 001, 2012). Fifty two percent of overall respondents were either satisfied or extremely satisfied with the military retirement system[10]. Less than half (45%) of respondents for the Army and Marine Corps responded that they were either satisfied or extremely satisfied, while at the high end, 63% of Air Force respondents were either satisfied or extremely satisfied. Only one demographic, male enlisted members, fell below 50% when answering this question, with the answers from Army and Marine Corps enlisted members pulling this average below 50%. When asked how they felt their retirement benefits compared to those of their high school classmates, 76% responded either "better" or "much better" than

[10] For comparison, 76% of respondents were either satisfied or extremely satisfied with medical benefits.

their high school peers[11]. When asked if saving for retirement was a goal, 48% indicated they were currently saving for retirement, with only 42% of enlisted respondents currently saving, as compared to 77% of officer respondents who are currently saving.

There are two remaining concerns regarding the U.S. military retirement system: the equity of a system that requires 20 years before it vests and its cost. The Defense Manpower Commission in 1976 first looked at the cost of the military retirement system. At that time, several recommendations were made to slow the growth in costs, one of which was to allow members who occupied combat jobs to retire with 20 years of service, while those occupying non-combat jobs could retire after reaching 30 years of service (Hudson, 2007). While this recommendation was not implemented, there were no less than nine subsequent attempts to review the military retirement system, a few which implemented changes (such as REDUX) (Hudson, 2007). Some were stand-alone reviews, while others were conducted under the auspices of reviewing total military compensation; nonetheless, cost and equity were primary considerations in most, if not all of these initiatives.

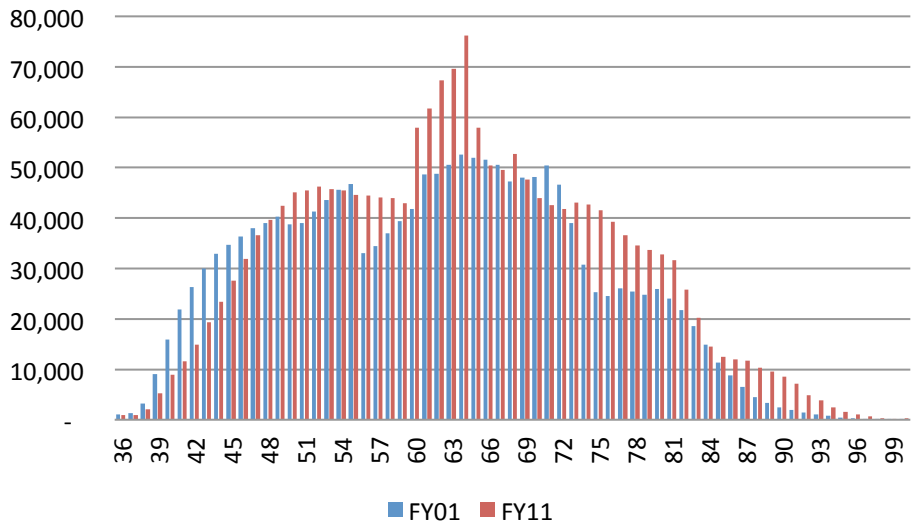
Since the Defense Manpower Commission of 1976, the number of military members receiving retirement pay has grown by 76%, from 1.1M to 1.93M in 2011 (DoD Office of Actuary, May 2012). As of Fiscal Year 2010, there were approximately 440,000 more retirees than active duty members and full-time reservists[12]. Retirees are also living longer. Figure 1 shows the growth in retirees in each age group. While this growth rate may not seem alarming, the size of the annual pension obligation has grown orders of magnitude more than the growth in retirees, equaling 596% growth (from $7.3B to $50.7B) over this same period (DoD Office of Actuary,

[11] For this question, health care scored 82%.

[12] A full-time reservist is someone who is serving in an active duty status but belongs to the active reserves.

May 2012). The Congressional Budget Office (CBO) projects this number will increase by 50% over the next ten years (CBO, 2012), while it is expected to grow by a magnitude of 5 fold by the year 2060. Due to this explosive growth in retirees and obligations, the pension fund is currently only 26% funded (Valuation of the Military Retirement System, 2012).

Figure 1 Change in Retirees



Prior to the passage of Public Law 98-94, the military retirement system was pay-as-you-go, with the services funding their respective liabilities from their annual appropriations. In 1984, Congress created the Military Retirement Fund and established "an aggregate entry-age normal cost funding method" (Valuation of the Military Retirement System, 2012, page 12) that requires the services to pay for the normal cost of retirement and the Treasury to make payments to eliminate the unfunded liability, which equaled $530 billion when the fund was established. This unfunded liability now stands at $1 trillion. Unlike Social Security, however, which has dedicated receipts to pay current beneficiaries, with any excess used to purchase

non-market debt securities, the Military Retirement Fund exists solely as an appropriation line item, through DoD or Treasury. In Fiscal Year 2010, the pension fund paid beneficiaries $50.6B; the services paid $20.4B into the fund, the Treasury paid $63.1B, and the fund itself earned interest income of $10.1B. The earned interest is of note, though, as this comes from special Treasury "obligations" unavailable to the public. These securities carry a market rate of interest as determined by the Secretary of Treasury (Valuation of the Military Retirement System, 2012, page 17). The most telling statistic is the statement of assets, which shows an asset balance of $321 billion in the Military Retirement Fund, although all but $25 million of these assets consists of intra-governmental securities or interest from intra-governmental securities. Of course, the only way to satisfy the future obligations associated with intra-governmental securities is through borrowing, use of tax receipts, or other governmental income (CBO, 2012).

The other issue of interest is equity within the current US system. Of the 1.4M current active duty retirees who chose to retire (non-disability retirees excluding retired reservists), more than half retire at 20 years of service (51.9 percent), 63 percent retire within the first two years of eligibility, and almost 73 percent retire within their first three years of eligibility. (Valuation of the Military Retirement System, 2012) This suggests there may be pent up demand to retire and that some people may extend their time of service in the military simply to avoid the loss of retirement benefits[13]. However, from 1993 to 2002, DoD temporarily offered members the opportunity to retire with as little as 15 years of service, accepting a 1% reduction for each year of service less than 20 years, up to a maximum of a 5% reduction in

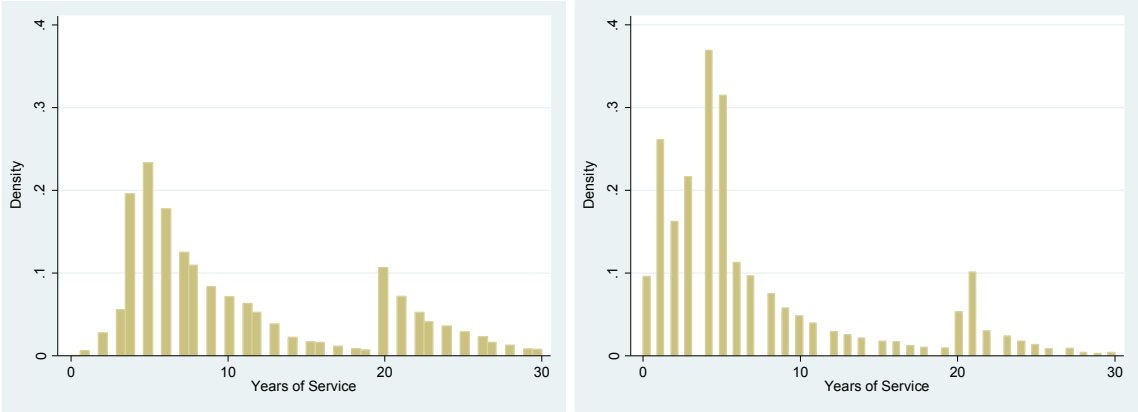
[13] Members selected for separation involuntarily may receive a lump sum payment that is based on their rank and years of service. For example, an E-6 with 15 years of service would receive approximately $62,000. A captain (O-3) with 8 years of service would receive approximately $52,000. There are many stipulations, though, to earn full involuntary separation pay.

their immediate annuity; however, any member accepting early retirement was treated as a regular military retiree concerning any cost of living protection. During this time, only 2.5% of all eligible officers and 3.4% of all eligible enlisted members accepted this offer, for a blended take rate of 3%.

Military end-strengths are determined by law annually, giving rise to the moniker "up-or-out". Enlisted members are subject to high year tenure rules, while officers are governed by the Defense Officer Personnel Management Act (DOPMA) of 1980. The small proportion of those who enter active duty and then stay to retirement is quite stark: a military compensation study conducted in 2006 calculated the probabilities of reaching 20 years of service for enlisted members and officers is less than 10% and 40%, respectively. (Report of the Defense Advisory Committee on Military Compensation, 2006) Warner (2008) shows similar survival rates for enlisted, but much lower rates (approximately 20%) for officers. The 2006 DACMC study also shows the proportion of loss over time for a given cohort, based on steady-state loss rates. The highest proportion of loss for both officers and enlisted members occurs at the four-year point (see Figure 2). The lowest observed proportion of loss for enlisted members at the four year point is 18%, with the Marine Corps experiencing a proportion of loss in excess of 40%. The trend quickly drops below 5% and then reaches steady-state around the 11 year mark. For officers, it is not nearly so well-defined. The peak occurs at the four year point, as well, with an average proportion of loss across all four services of about 13%, but the decline to steady state is much more gradual, with three services seeing a proportion of loss for officers above 5%, even as late as year 10, reaching the steady state around the 14 year mark. For both enlisted members and officers, the next largest spike is at the 20 year point. Warner (2008) generally

has lower survival rates at each year of service, but the overall conclusion is that, while the system is costly, a surprisingly small number of members actually collect retirement benefits.

Figure 2 - Years of Service Completed at Separation: Officers, Enlisted



Where this is most disconcerting, though, is in combat arms occupations. Combat arms is defined as those jobs that participate in the employment of force (e.g. infantry). While the line between combat and non-combat is increasingly blurred with extended conflicts in Iraq and Afghanistan, members in combat arms military occupational specialties (MOS) bear the brunt of the most onerous and dangerous assignments, yet it is these same members who typically separate before reaching 20 years. Combat arms occupations are thought of as "a young person's game", with many in these occupations separating after their second tour of duty; thus, a system that requires an individual to serve 20 years before collecting benefits is inequitable to those who are most likely to need the benefit and who, ironically, do not necessarily earn skills that are immediately transferable to the private sector without further investments in human capital.

This paper does not offer alternative retirement proposals for consideration. Much has been done to suggest changes that may make the retirement system more equitable and cost effective. Many (see Warner (1979), Asch and Warner (1994), Asch *et al.* (1998), and others) have investigated alternatives by estimating a simulation model that replicates current retention rates and examines the effects of possible changes to the military retirement system. There have been several iterations, which are beyond the scope of this paper, but most (see Asch *et al.* (2008) as the most recent example) have coalesced into considering some combination of a defined contribution plan, a defined benefit plan with a lifetime annuity at a much later age (Asch *et al.* consider age 57), a series of cash payments during a service member's career, and different proposals about when each plan vests. The most recent proposal as submitted by the Defense Business Board (October, 2011) would move completely to a defined contribution plan, with risk adjustments for combat tours, family separations, and other hardships. This plan would also offer different payout options, to include immediate lump sum or traditional annuity, as well as a right of survivorship, which is currently unavailable without paying an expensive premium.[14]

The issues associated with the U.S. military retirement system are well-documented and now updated. We started this discussion by noting that the military retirement system becomes a topic of conversation when there are fiscal issues or recruiting and retention issues. With fiscal issues bringing this discussion to the forefront yet again, we now focus on

[14] The current defined benefit plan ends with the death of the military member, unless the member chooses an option entitled Survivor Benefit Plan (SBP). The most likely choice, full coverage for spouse, involves paying a premium of 6.5% of monthly retirement pay. This premium insures the member's spouse will continue to receive 55% of the monthly retirement payment over her life span, assuming the military member precedes the spouse in death. SBP is considered paid in full after 360 months of paid premiums.

uncovering what role the retirement system plays in an individual member's decision to continue to serve, to the extent that it is their decision.

Model

Our approach most closely follows the work by Asch *et al.* (2005), which builds upon the early work of Stock and Wise (1988). Models based on Stock and Wise are called "option value" models, in that they presume an individual will continue to work until the retirement option provides greater utility as defined by the discounted value of the income streams for each of the two options.[15] The other most prevalent method of modeling the retirement decision, be it military or civilian, is a stochastic dynamic programming model[16]. While stochastic dynamic programming models are computationally more complex, Lumsdaine, Stock and Wise (1992) set out to test the performance of dynamic stochastic programming models as compared to option value models as developed by Stock and Wise, recognizing that "…more complex specifications may presume computational facility that is beyond the grasp of most real people…" (pg 22) They conclude that both models perform better than other alternatives, based on in- and out-of-sample predictions, but that neither is preferred to the other. The option value model did a slightly better job when the retirement plan changed; given the passage and subsequent repeal of REDUX, we chose the option value framework.

The model assumes that in year *s*, a military member will earn Y_s income by serving in the military. If in year *s* they leave the military, the member will earn a civilian salary C_s plus any retirement benefits B_s presuming at least 20 years of military service. The indirect utility

[15] Asch *et al.* (2008) model the decision to leave active duty but include reserve service as an option. This creates a nested specification with two options, where the second option (leave active duty) itself has two sub-options (enter the reserves or enter civilian life).

[16] See Duala and Moffitt (1991) as an example of a stochastic dynamic programming model applied to military retirement.

function (eq 1) consists of utility derived from military income in year *s, $U_m(s)$*. Individuals apply the appropriate discount factor **δ to** any future earnings, and expect to live until year *T.* The indirect utility they experience once they begin to earn a civilian salary and retirement benefits (if applicable) in year *r* is represented by *$U_C(s)$*.

$$V_t(r) = \sum_{s=t}^{r-1} \delta^{s-t} U_m(s) + \sum_{s=r}^{T} \delta^{s-t} U_C(s) \quad (1)$$

The value of choosing to separate from the military in the current time period is represented by equation (2):

$$V_t(t) = \sum_{s=t}^{T} \delta^{s-t} U_C(s) \quad (2)$$

An individual will choose to separate from the military in the current time period if the expected gain in utility from delaying retirement until time period *r* is negative. That is to say, equation 3 demonstrates that an individual leaves when $G_t < 0$.

$G_t(r) = E_t V_t(r) - E_t V_t(t) < 0$, where E_t is the expectation at time *t* (3)

Previous researchers (Stock and Wise (1988) and Ausink and Wise (1996)) impose the condition that an individual facing the decision to separate considers all future departure dates, and they choose to depart when r^*, which is the maximum gain from staying across all future departure dates, is less than zero. However, our data show that there is an extraordinarily large

exodus of military members when they reach 20 years of service,[17] when they first become eligible to receive retirement benefits. From this stylized fact and our contact over time with members of the military, we believe members with less than 20 years of total service give major consideration to two options: remain in the military for 20 years of service and become eligible for retirement benefits, and leave the military now for whatever option is now available in the civilian labor market and forfeit military retirement. Hence, for years of service less than 20, our model computes the difference in expected utility between these two options. For members with 20 or more years of service (who are retirement eligible), our model computes which year between the current and mandatory retirement at 30 years of service maximizes expected utility. Thus, r^* is assumed to be *20* until the member exceeds 20 years of service and then r^* *is determined by an iterative maximization process* We let $\pi(s|t)$ represent the probability of living to age *s* given a present age of *t*, assume a constant relative risk aversion functional form where the risk aversion parameter is represented by γ. *T* is the maximum possible age, which we assume to be 120 in accordance with Social Security Administration Life Tables. Finally, *k* represents the fact that utility earned from retirement income is different than income earned while exerting effort. With these assumptions[18], the expected gain is estimated by equation (4):

[17] DMDC research shows that 52% of officers retire at 20 years of service, with fully 73% of members leaving by 23 years of service.

[18] Following Samwick (1998), Coile and Gruber (2001) and Asch *et al.* (2005), we initially set k=1.5, γ=0.75, and δ=0.95.

$$G_t(r^*) = \sum_{s=t}^{19} \delta^{s-t}\pi(s|t)E_t Y_s^{\gamma} + \sum_{s=20}^{T} \delta^{s-t}\pi(s|t)E_t\left[\left(C_s(20) + kB_s(20)\right)^{\gamma}\right] - \sum_{s=t}^{T} \delta^{s-t}\pi(s|t)E_t C_s(t)^{\gamma} \quad t = 1..19 \tag{4}$$

$$G_t(r^*) = \sum_{s=t}^{r^*-1} \delta^{s-t}\pi(s|t)E_t Y_s^{\gamma} - \sum_{s=t}^{r^*-1} \delta^{s-t}\pi(s|t)E_t[(C_s(s) + kB_s(s))^{\gamma}] \quad t = 20..30$$

We incorporate the option value calculation of expected utility into a model of duration that includes other demographic explanatory variables. Hausman and Wise (1985) use this specification to model the time to retirement. Lancaster (1979) uses the duration model to estimate the duration of unemployment. More recently, Gurley-Calvez and Bruce (2008) use a duration model to study the effects of tax cuts on entrepreneurial longevity. Likewise, we use a duration model to estimate the effect of indirect utility from military retirement benefits, controlling for demographic explanatory variables, upon the "survival" (or non-retirement) of a military member into the following time period. Duration models were first used in the field of medicine to determine efficacy rates, as well as the mean time between failures. Failure is defined to occur when the subject experiences an event, which in our model is the decision to leave the military. Duration models are broadly classified as either a proportional hazard, where each member's individual hazard function (probability of experiencing an event through time) is a vertical shift of a common non-parametric hazard function, or an accelerated failure time specification in which the hazard function is parametrically determined. Our data rejected

the proportional hazards hypothesis for all but two variables and for the overall model, leading us to choose an accelerated failure time specification.[19]

The accelerated failure time model is specified as follows:

$\ln(t_j) = \overrightarrow{x_j}\overrightarrow{\beta_X} + \ln(\tau_J)$	(5)

where τ_j is assumed to follow a statistical distribution, the most popular of which are exponential, Gompertz, Weibull, generalized gamma, lognormal, and loglogistic. The irregular shape of Figure 2, Years of Service Completed at Separation, does not neatly conform to any of the shapes generated by the previously mentioned distributions, complicating our choice of which distribution to use. Of the distributions mentioned above, the generalized gamma alone is able to model regions of decreasing hazard, then increasing hazard. This "bathtub shape" accounts for the popularity of this functional form in mortality-based studies. The other functional forms above specify hazard functions that are either monotonically decreasing, monotonically increasing, but never with regions that are both decreasing, then increasing. In addition to allowing more flexible shapes, the Weibull, exponential, and lognormal distributions are all special cases of the generalized gamma distribution and can be tested within a nested structure. Thus we begin with a generalized gamma distrubtion. When allowing the categorical variable *redux* to affect the shape of the survival function, we failed to find a statistical difference between the generalized gamma and lognormal specifications. Therefore, we assume a lognormal distribution. We note that Warner and Pleeter (2001) use both a linear and lognormal model in their analysis of personal military discount rates.

[19] Results of proportional hazard specification tests are available from the authors upon request.

Data

Our work draws on data that are maintained at the Defense Manpower Data Center (DMDC). Our interest focuses on the retirement system's effects on active duty military members; as such, DMDC provided us with every active duty military member from 1981 through 2011. The data consist of an observation that indicates when a transaction took place, with transaction defined as either a gain or loss to active duty. Thus, we only use accession data up through 2007. This allows a member who enters active duty after 2007 to have an opportunity to make a decision to either remain on active duty or separate. Additionally, there is an annual status observation for each year that a member is on active duty. These data exist through 2011. Given a 30-year time frame, our data contains 10 entering cohorts for which we can observe an entire military career from accession through retirement at 20 years of service. Since survival models are able to consistently utilize left-censored observations for which the beginning of risk is not observed, we include in our data set members of the military who entered service after the end of military conscription in 1973. Previous research focuses on enlisted members, or occasionally a specific officer occupational category. Our dataset includes both enlisted members and officers, although we find it advantageous to estimate each separately.

We gather military pay data from the Defense Finance Accounting Service, which maintains historical pay tables across the relevant time span. Borrowing from behavioral finance literature and noting that individuals tend to overweight the most recent past, we use

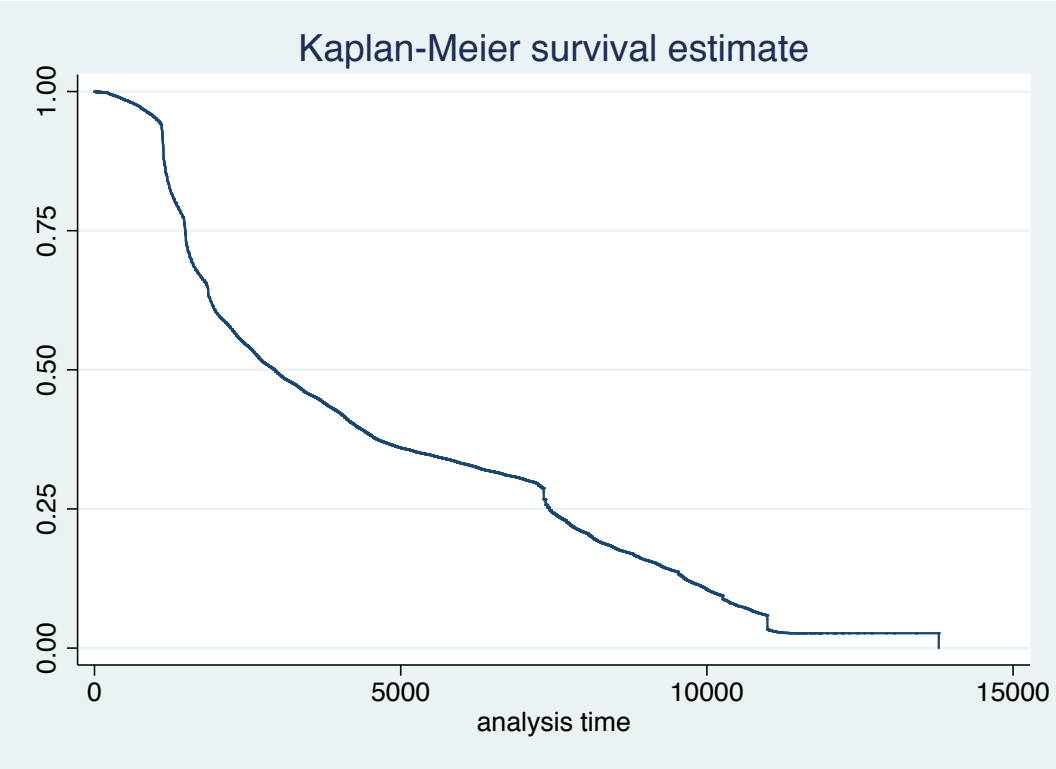
an average of the most recent three years of military pay raises,[20] at the time the individual makes their decision, as the growth rate for military wages and retirement payments[21]. Since expected utility is a function of the difference between military and civilian wages, we use broad occupational categories collected from the Current Employment Statistics series maintained by the Bureau of Labor Statistics. We use weekly average wages across broad civilian categories, which are necessary to have observations that span the entire timeframe of our military data, and converted these into annual, real earnings using the CPI. As with military pay raises, we grow civilian wages using a three-year average of the year-over-year change in the employment cost index, at the time that the individual makes their decision. We use probabilistic life expectancies in the expected utility calculations taken from life tables as prepared for actuarial study 120, which is a report produced every three years by the Social Security Administration. (Bell and Miller, 2005) The probability of survival beyond age 115 is effectively zero.

Results

Figure 3 shows the baseline survival function estimated across all the officer data. This graph demonstrates the estimated probabilities associated with continuing on active duty.

[20] FY12 DoD Greenbook provided annual military pay raises. For some years, where there were multiple pay raises or targeted increases (e.g. 2002), the Greenbook calculated an average annual pay raise.
[21] Military retirement is fully indexed for inflation, starting the year after the individual retires, except for those who accepted the REDUX retirement.

Figure 3
Graph of Baseline Survival Function for Officers



The Kaplan-Meier survival function captures what we observe in real life; the four- and eight-year point offer the largest probability of separation for officers. Once an officer has served for at least eight years, the probability of surviving until retirement remains fairly constant. We model the hazard function associated with retirement for military members, where survival until retirement is controlled by the option value of retirement and various demographic factors including marital status, gender, and branch of service. Time is measured in days, which causes a natural smoothing effect with some observations extending over 10,000 days[22]. We also include unemployment as a proxy for the perceived difficulty of obtaining a civilian job, as

[22] We explain below that retirement is mandatory for most members of the military at 30 years, or 10,950 days. We treat mandatory retirement at 30 years as a right-censoring of the data since the desired duration of service is likely longer. The estimated survival function shows a positive probability of service beyond 30 years because of this censoring.

well as the variable *redux* that identifies a member who enters active duty between 1986 and 2000 and faced reduced retirement benefits until its repeal in 2000, the variable *drawdown* which corresponds to the time period after 1990 when the military offered voluntary incentives to try to reduce the size of the active duty force, and a variable *eligible* that identifies when a military member is eligible to retire. Since we attempt to model the decision of when to leave the military using a duration model, we must carefully consider the case of those members who are forced to retire upon reaching 30 years of service. These individuals are assumed to fail only because the system requires them to retire; thus, it is likely they would continue on active duty if not for the law mandating retirement upon reaching 30 years of service[23]. While Samwick (1998) and Asch *et al* (2005) use a discount rate of 5%, Warner and Pleeter (2001) estimate discount rates based on the selections made by officers and enlisted members during the drawdown period when voluntary incentives were offered to service members. During this period, the DoD offered either a lump sump or an annuity, with the total number of years of service dictating the length of payments. They estimate discount rates for officers that range from 10% to 19% and enlisted members that range from 35% to 54%. Accordingly, we begin the analysis for officers using a 5% discount rate, but we calculate option values for discount rates of 10%, 15%, and 20%.

Table 3 represents the results of models 1 and 2. Model 1 is the model we developed, to include the option value of retirement. While we are estimating indirect utility associated with the option value, represented by *g* in equation 4, note that the difference between wages

[23] A small proportion of officers, mainly Presidential appointees including Admirals, Generals, and service academy department chairs, can serve beyond 30 years. In our data, these cases are coded as continuing

and the present value of retirement is additively separable. As such, model 2 tries to isolate the effect of the present value of the retirement annuity, by separating the wage differential from the retirement annuity, and estimating the effects separately. Within the duration framework, the accelerated failure time models estimate the effect of a variable on the probability of survival. Thus, positive coefficients represent an increased probability of survival, which in our context is remaining on active duty. For model 1, the signs of all estimated coefficients are consistent with our *a priori* expectations. Of primary interest, the coefficient on option value is positive, indicating that as continued military service is more attractive relative to leaving the military, the probability of surviving becomes larger. Being in the Air Force, Navy, and Marines all contributes positively toward survival as compared to service in the Army, which is the omitted category. Likewise, minority service members are more likely to survive, while females are less likely to survive. The coefficients on *redux, drawdown, eligible,* and *unemployment* are all negative, indicating that these variables reduce the probability of survival.

For model 2, when we disaggregate the utility effects of the military-civilian wage differential and the present value of retirement, the wage differential is negative while the effect of the present value of retirement is both positive and larger than the option value in model 1. This indicates that, across the spectrum for officers, the retirement benefit not only has a positive effect on retention, but it is potentially larger than previously thought. One caveat, though, is we have no way of estimating a retirement benefit differential, taking into account the possible retirement benefits associated with civilian employment. This is a prevailing problem throughout the previous literature as it pertains to calculating the option

Table 3
Survival analysis for officers at the 15% discount rate

	Model 1		Model 2	
	Coefficient	Std Error	Coefficient	Std Error
Option Value	0.211	0.0012		
Wage differential			-.048	0.006
Present Value of Retirement			0.314	0.003
Married	0.327	0.008	0.375	0.010
Divorced	0.135	0.021	0.108	0.026
Female	-.260	0.010	-.288	0.012
Unemployment	-.038	0.002	0.051	0.004
Redux	-.354	0.017	-.338	0.020
Drawdown	-.446	0.010	-.741	0.014
Eligible	-1.467	0.037	-1.886	0.051
Air Force	0.275	0.008	0.291	0.010
Navy	0.112	0.008	0.084	0.010
Marines	0.559	0.015	0.664	0.018
Nonwhite	0.168	0.009	0.205	0.011
Constant	7.541	0.019	6.91	-.029
Note: All coefficients are significant at the 99% confidence level				
Number of subjects	232,711		232,711	
Number of Exits	158,706		158,706	

value. Therefore, we view the magnitude of the retirement coefficient as the upper bound of the effect. All other variables maintain the same sign and approximately the same magnitude, save for unemployment. Curiously, the sign on unemployment changes from model 1 to model 2, while both remain highly statistically significant. Unfortunately, we do not have an explanation for this change.

To consider the magnitude of the change, we must exponentiate the estimated coefficients. Most importantly, a $10,000 change in the option value on the margin increases

the probability of survival by 24%. By comparison, being married increases the probability of survival by 39%. Of the variables that are correlated with decreasing survival, entering active duty during the Redux era reduces the probability of survival by 30%, while the probability of survival declined even more for an individual during the "voluntary" drawdown, with survival probabilities declining by 36%. Females were 23% less likely to survive the event as males, while minority service members were 18% more likely to survive. In model 2, the wage differential reduces the probability of survival by 5%, while the present value of retirement increases the probability by 37%. This is a 13-percentage point increase, but more dramatically it is a 54% increase in the probability once the negative effects of the wage differential are disaggregated.

Conclusion

The US military retirement system, little changed since 1948, offers a pension of 50% of basic pay from the final 3 years of service for the life of the beneficiary after 20 years of service. These benefits appear quite generous when compared to those of allied nations and the American private sector, and are becoming increasingly costly to the Department of Defense (DoD). Surveys of military members indicate that many do understand the generosity these retirement benefits and are concerned about the possibility of changes to the system. The "all or nothing" nature of the system requiring members to serve a minimum of 20 years before qualifying for any retirement benefits potentially distort the decision of when to leave the military in order to qualify for benefits.

Using data on members of the US military from 1981 through 2011, we estimate a survival model in which the probability of continuing in military service is a function of the estimated option value of continued military service, including retirement, and other demographic variables. We find the option value of continued military service to be large and very significant. On the margin, an additional $10,000 of option value increases the probability of survival by 24%. By comparison, married members are 39% more likely to survive relative to never married members.

While expensive for DoD to provide, current retirement benefits do appear to be valued by members and significantly affect the decision of whether to remain in the military long enough to become retirement eligible.

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VARIABLES	(1) Officer Sample mean (sd)	(2) Enlisted Sample mean (sd)
Member Leaves Service	0.0751	0.335
	(0.263)	(0.472)
Option Value*	3.809	-0.454
	(3.594)	(1.812)
Wage Differential*	1.141	-1.120
	(0.947)	(1.014)
Present Value of Retirement*	2.668	0.666
	(3.211)	(1.144)
Male	0.868	0.869
	(0.338)	(0.337)
Army	0.388	0.402
	(0.487)	(0.491)
Air Force	0.276	0.228
	(0.447)	(0.420)
Marines	0.0626	0.1256
	(0.242)	(0.331)
Navy	0.273	0.242
	(0.445)	(0.428)
Drawdown	0.223	0.215
	(0.417)	(0.411)
Age	34.252	25.648
	(6.124)	(6.697)
Years of Service	12.117	6.324
	(5.994)	(6.097)
Years in Rank	2.736	1.488
	(2.298)	(2.199)
Never Married	0.194	0.516
	(0.395)	(0.500)
Married	0.775	0.446
	(0.417)	(0.497)
Divorced	0.0284	0.0283
	(0.166)	(0.166)
Unemployment Rate	6.154	6.377
	(1.452)	(1.497)
Observations	2,115,498	13,183,055
Number of Members	232,807	5,528,044

* Both officer and enlisted values shown are computed using a 15% discount rate.