CHOOSING TO SERVE: UNDERSTANDING THE MILITARY PARTICIPATION DECISION

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A DISSERTATION

in

Economics

Presented to the Faculties of the University of Pennsylvania in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

2011

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To Rose Marie

Acknowledgments

I would like to thank my dissertation committee members Ken Wolpin, Petra Todd, and Flavio Cunha. Throughout the dissertation process, Ken challenged me to think clearly and critically about the questions I was asking and my approach to answering them. Petra's insight and advice greatly assisted in the latter development and presentation of this dissertation. I am grateful to Flavio for encouraging me while taking his graduate course to start developing original work. Additionally, Flavio's critiques of this project were extremely helpful.

I would also like to thank my officemates and fellow graduate students Karam Kang, Fatih Karahan and Kurt Mitman. From preparing for first year qualification examinations through the development of my dissertation, I have greatly benefited from their advice, assistance, and friendship and wish each of them the very best in their future endeavors.

Throughout my life, my family has blessed me with constant love and support. Without them, nothing that I have accomplished would have been possible. To my mother, sisters, and grandparents, I thank you.

Finally, I would like to thank my wife, Rose Marie. Your constant love and support have enabled me to achieve my greatest goals. I am extremely blessed to have you in my life.

ABSTRACT

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With 2.4 million employees, the military is America's largest employer. Individuals make the military labor force participation decision within the context of other labor market opportunities, which may vary by race and over the business cycle. This paper develops and estimates a dynamic discrete choice model of lifetime career decision making that incorporates military options. In the model, forward-looking individuals receive wage offers from the civilian and military sectors and decide whether to work in the civilian sector, attend school, stay home, serve active duty military, or serve reserve duty military. The model describes the military's compensation structure and recruitment policies in detail and introduces business cycle effects that affect civilian labor market opportunities. The model is estimated by simulated maximum likelihood using data on males from the NLSY79. Parameter estimates reveal that the civilian sector places a high premium on civilian experience relative to military experience. The model fits well military participation patterns and dynamics, including by race and over the business cycle. The model is used to perform experiments that alter the military compensation and promotion structure. Results indicate that military participation is highly elastic with respect

to changes in the wage rate. Other experiments reveal that blacks' participation in the military drops dramatically as the racial wage gap in the civilian sector decreases. Experiments that alter the length and severity of business cycles result in military participation rate effects that range from 3% to 6%.

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Chapter 1

Introduction

With a fiscal year 2008 personnel budget of $114 billion and 2.4 million employees, the United States military is America's largest employer.[1] Each year the military adds approximately 200,000 new recruits, who on average are 18 to 20 years old at time of enlistment and serve about six years. Men comprised 91.6% of military recruits in 1980 and 85% of recruits in 2002. [2] The military recruits this workforce despite paying an average entry level wage that is 12% lower than the average 18 year old's civilian sector wage.

Individuals are motivated to join the military for different reasons. Some individuals join because they are endowed with abilities that provide them with a comparative advantage in military service. There is evidence that blacks join the

[1] Figure A.1 reports total annual military spending from 1947 through 2004. From the Center for Defense Information.

[2] Population Reference Bureau (2004), Department of Defense (2008), Bureau of Labor Statistics (2010)

military at relatively high rates because the civilian sector usually offers them a wage that is lower than the wage offered to whites.[3] When compared to whites, blacks are 33% more likely to join the military.

The military participation decision is also affected by macroeconomic conditions. When the economy is expanding, military recruitment and retention suffer. For example, the military retention rate during late 1990s - a time of economic expansion - was low enough to convince Congress to approve in 2000 a significant pay increase for experienced military personnel.[4] During recessions, however, recruitment and retention thrive. The Department of Defense reported that fiscal year 2009 - a year of sharp economic contraction - was its most successful recruitment year since conscription ended in 1973.[5]

The discussion above generates several research questions. First, to what extent does the civilian sector value military experience? Second, how do the military participation rate and average military career length change as military wages are altered? Third, instead of increasing retention by increasing the military wages of experienced personnel as Congress did in 2000, what would have happened if the military had instead increased the promotion probabilities of experienced personnel?[6] Fourth, how do the military participation rate and average military career length change among blacks as racial differences are removed from civilian sector

[3] Kane (1994); Laurence (1992); Moskos & Butler (1996)
[4] Asch *et al.* (2002)
[5] United States Army (2009)
[6] Buddin *et al.* (1992)

wage offers? Fifth, does removing the education attainment gap at age 18 between whites and blacks significantly decrease black military participation? Sixth, to what extent does the business cycle drive military participation?

To examine the research questions above, this study develops and estimates a dynamic discrete choice model of lifetime career decision making that incorporates various military options.[7] The model assumes that starting at age 18 and ending at age 65, individuals annually receive wage offers from the civilian and military sectors and then make a decision regarding whether to work in the civilian sector, attend school, stay home, serve active duty military, serve part-time in the reserve military and work in the civilian sector, or serve part-time in the reserve military and stay home.[8] Individuals are forward-looking and make decisions taking into account the expected future impact on earnings opportunities. When making their sector participation decisions, individuals face uncertainty regarding future wage and preference shocks.

The model captures in detail important features of the military's compensation structure and recruitment policies. In accordance with the military's recruitment policies, the model prohibits some individuals who perform poorly on the Armed Forces Qualification Test, or AFQT, from joining the military. Military wages are a function of pay grade (i.e., rank) and military experience, which both evolve endogenously. Promotion is modeled as a probabilistic event conditioned on current

[7] Several models have solved problems of this type, including Eckstein & Wolpin (1999).

[8] Reservists typically serve one weekend a month as well as an additional two weeks during the year.

pay grade and military experience. Minimum experience thresholds must be met in order to be considered for promotion. Eligible veterans receive pension payments, which begin either at age 60 or upon leaving the military.

The model also incorporates business cycle effects, which are known to be important to sector participation decisions. Specifically, individuals who enter the civilian workforce after an absence pay a job search cost that varies by the business cycle state. A Markov chain describes the transition probabilities between business cycle states.

To enrich individual heterogeneity within the model, it is assumed that there exists within the data a finite mixture of unobserved types.[9] Skill and preference endowments vary across types. The probability of being a certain type is a function of observable characteristics such as race.

In addition to racial differences in type probabilities, the model allows civilian sector wage offers to vary further by race. Since this additional variation can be attributed to civilian sector racial discrimination and it is assumed that the military cannot discriminate, military sector wage offers are not allowed to vary further by race.

The model is estimated by simulated maximum likelihood using male data from the 1979 National Longitudinal Survey of Youth, or NLSY79. In addition to containing a nationally representative sample, the NLSY79 includes a military oversample, which is comprised of individuals who were serving active duty in 1979.

[9] Types are multinomial, as in Heckman & Singer (1984).

The sample used for the analysis is a weighted combination of the nationally representative sample and military over-sample. In addition to including data on age, race, education attainment, civilian labor force experience and civilian earnings, the NLSY79 contains military data, including AFQT score, military pay grade, military labor force experience, and military earnings. The NLSY79's inclusion of pay grade, military experience, and military earnings data makes detailed estimation of the military wage structure possible. The model fits well military participation patterns and dynamics, including by race and over the business cycle.

The estimated model is informative about the key mechanisms driving military participation over the life cycle. Individuals endowed with the highest military skills are not the most likely to join the military. Rather, individuals endowed with high military skills relative to their other skill endowments are most likely to join the military. The civilian sector search cost rises as the business cycle state worsens, which incentivizes military participation when aggregate economic conditions deteriorate. Relative to whites, civilian sector wage offers are lower on average for blacks. Facing relatively lower civilian sector wage offers, blacks are more likely to accept military wage offers, which do not vary directly by race. The civilian sector places a high premium on civilian sector experience over military experience, which helps to explain why on average veterans earn less in the civilian sector than individuals who never serve in the military.

The estimated model is used to conduct several counterfactual experiments that explore the research questions above. A set of experiments alters military pay by varying degrees and shows that military participation is highly elastic with respect to changes in the wage rate. A 1% increase in military pay increases the military participation rate by about 5%. While the military participation rate increases significantly as military wages increase, the average military career length experiences a more modest increase in response to higher military wages. The military pay experiments also reveal that, when compared to individuals already serving in the military, the recruits attracted by the higher military wage are less likely to have an AFQT score in the lowest quartile. Since individuals with an AFQT score in the lowest quartile are viewed by the military as the least desirable recruits, increasing military wages improves the proportion of desirable recruits in the military.

To understand what would have happened to average military career length if the military had increased promotion probabilities in 2000 instead of increasing military wages, two experiments are conducted. The first experiment increases promotion probabilities for all experienced military personnel. The experiment results in an 18% increase in average military career length. The second experiment increases promotion probabilities for all experienced military personnel who have completed at least one year of college. The experiment results in a 3% increase in average military career length. The military participation rate in both experiments does not change.

Some experiments attempt to understand to what extent racial differences in civilian wage offers are responsible for the relatively high military participation rate of blacks. In one experiment, the racial difference in civilian sector skills or human capital rental rate is removed. As a result, the black military participation rate decreases by 38%. Another experiment changes the education attainment distribution of blacks to match the education attainment distribution of whites. Altering the education attainment distribution of blacks alters their civilian sector human capital, which affects the civilian sector wage offers they receive. The second experiment decreases the black military participation rate by 32%.

The final experiments investigate to what extent business cycle fluctuations affect military participation. An experiment removes business cycle fluctuations from the model and results in a 6% decrease in the military participation rate, which suggests that military participation is more sensitive to poor business cycle states than to good business cycle states. To determine to what extent experiencing a single poor business cycle state early in life affects the military participation rate, another experiment forces all individuals to experience the poor business cycle state at age 18 followed by no business cycle variation. The experiment results in a 13% increase in the military participation rate.

1.1 Related Literature

Several publications have examined various military labor force topics. Some publications, including Teachman & Call (1996); Angrist (1998); Hirsh & Mehay (2003), examine the effect military experience has on civilian wages. Among these publications, Angrist (1998) and Hirsh & Mehay (2003) stand out because both control for selection into the military. Hirsh & Mehay (2003) conduct a matched comparison between military reservists who are called to active duty and military reservists who never serve active duty. Using military and Social Security Administration data, Angrist (1998) controls for selection into the military by comparing veterans to military applicants who did not enlist as well as by creating an instrument using cohorts of veterans who entered the military when the military entrance examination was misnormed. These two publications find that for enlisted personnel, white military veterans earn less in the civilian sector than whites who never enlist. Black veterans earn slightly more than blacks who never enlist. While these two studies discover that on average being a veteran adversely affects civilian wages, both can only speculate regarding the mechanism that generates this earnings disparity.

A few publications have examined the decision to join the military. Hosek & Peterson (1985b) use a Department of Defense survey and the NLSY79 for data and find that the enlistment behavior of high school seniors and high school graduates are substantially different. Kilburn & Klerman (1999) use the National Educational Longitudinal Study sample to characterize military enlistment during the 1990s. Kleykamp (2006) studies how education goals, familiarity with the military, and socioeconomic factors influence the decision to join the military. Using data from the Texas high school graduates in 2002, Kleykamp (2006) surprisingly finds few racial and ethnic differences in enlistment behavior and concludes that college aspirations, living in a community with a high military presence, and low socioeconomic status promote military enlistment.

This study's features incorporate the findings of previous military participation studies. Consistent with Hosek & Peterson (1985b), in this study military participation incentives vary by education attainment. More specifically, in the model both the cost associated with attending school and the probability of qualifying for military service vary by high school diploma status. Contrary to Kleykamp (2006) and consistent with Kilburn & Klerman (1999) and most other studies' findings, this study includes racial differences in endowment and wage offers that allow military participation tradeoffs to vary by race.

Several publications have studied military retention, which is also referred to as the stay or leave decision. Methodological approaches vary widely among these publications and include (among others) panel probit models (Goldberg & Warner (1982); Black *et al.* (1987, 1990)), conditional logit models (Warner (1982)), and multinomial logit models (Hosek & Peterson (1985a); Lakani & Gilroy (1986)). Also included among these publications is Enns *et al.* (1984), which develops the widely used annualized cost of leaving, or ACOL, model.[10] These publications report many

[10] According to Goldberg (2001), the ACOL model models the military retention decision as a decision between two discounted pay streams. The projected military pay stream a serviceman would receive if he re-enlists is collapsed into a discounted present value. The discounted military pay stream is then compared to the projected civilian pay stream the serviceman would receive if he leaves the military. This comparison is done over a finite time horizon and results in a retention probability that can be easily modeled as a probit or logit function.

findings and often include a military wage elasticity. The samples for these studies vary substantially. Consequently, the military retention wage elasticities these publications report vary widely from under a percent to just under 4%. [11]

In the past 30 years, two studies have structurally estimated models that explore military retention. Gotz & McCall (1983) construct a retention model for Air Force officers. Among the first publications to structurally estimate a model, Gotz & McCall (1983) incorporates into the model various factors that influence the retention decision, including "promotion probabilities and timing, regular force integration probabilities, and mandatory separation and retirement probabilities." After estimating three parameters, Gotz & McCall (1983) perform counterfactual experiments that replicate the recommendations of a presidential commission on military compensation. Daula & Moffitt (1995) construct a retention model for Army enlistees and simulate behavior under the Army's Voluntary Separation Incentive program. Both papers use military data sets, study decision making after enlistment, focus on a specific service branch, and assume military retirees cannot exit the civilian labor force.

As described above, many previous military studies focus on military retention. While important, the stay or leave decision is not the only military decision individuals make. Before deciding whether to leave the military, individuals must decide whether to join the military. As Angrist (1998) and Hirsh & Mehay (2003) suggest, the military entry decision is very important as it has implications for future civilian

[11] Goldberg (2001) provides an excellent summary of these publications.

sector earnings. Furthermore, individuals who decide to serve reserve duty receive a low military wage but can also join the civilian workforce, while those who decide to serve active duty receive a high military wage but cannot join the civilian workforce. Given the importance of and tradeoffs associated with these decisions, this study models the military entry and service type decisions as well as the military retention decision.

In addition to including the military entry and service type decisions, the model presented in this study incorporates many additional features not found in Gotz & McCall (1983) and Daula & Moffitt (1995). First, this model allows military retirees to annually choose whether to work in the civilian sector or stay home, creating a choice set rather than assuming military retirees are always employed. Second, to show how policy changes would impact the entire military labor force, this study models the military participation decision across service branches. Third, to account for a factor that may heavily influence military participation, the study models the business cycle and how it impacts individuals' decisions. Finally, this model takes advantage of computational and methodological advancements over the past few decades to estimate a model whose complexity would have made it difficult to estimate in the past.

The model's structure is similar to that of Keane & Wolpin (1997) in that individuals can, among other choices, join the military. But the military is not the focus of Keane & Wolpin (1997). Consequently, Keane & Wolpin (1997) do not include military pay grade and military experience (the determinants of military human capital), do not distinguish between active duty and reserve duty military service, and do not restrict military enlistment on the basis of high school diploma or AFQT score. Furthermore, Keane & Wolpin (1997) use a sample restricted to white males, do not model the business cycle, do not model military pensions, and do not perform any military experiments.

Chapter 2

Military

In order to model the military participation decision, it is necessary to understand how the military screens, promotes, and compensates its personnel. In 1973 the military ended conscription, becoming an all volunteer force. Consequently, all individuals who join the military must choose to do so.

When joining the military, individuals may serve either active duty or reserve duty. Individuals serving active duty make military service their full-time job.[1] Those serving reserve duty, however, are required to serve only one weekend per month as well as an additional two weeks per year. Reservists may be called to active duty by order of the President or in some cases a state governor. No military experience is required to join either duty type (e.g., an individual does not have to first serve active duty in order to become a reservist). The military imposes a

[1]Figure A.2 reports active duty force size from 1950 through 2007. From the Department of Defense.

maximum recruitment age in the mid to late 30s and a mandatory retirement age in the late 50s to early 60s. [2]

Before qualifying for military service, individuals take a series of tests known as the Armed Services Vocational Aptitude Battery (ASVAB). The Armed Forces Qualification Test (AFQT) score is calculated from a subset of the ASVAB. By law the military cannot recruit individuals with an AFQT score in the lowest decile and only 25% of recruits may have an AFQT score in the second and third deciles. To qualify for military service, high school dropouts must have an AFQT score that exceeds a cutoff value. The AFQT cutoff value is usually around the median, varies by service branch, and varies over time.

The military uses pay grades or ranks to form its personnel hierarchy. The military has three rank classes: commissioned officers, warrant officers, and enlisted personnel. Commissioned officers receive their authority from a presidential commission, while warrant officers initially receive their authority from a warrant issued by the military. Commissioned officers outrank warrant officers and warrant officers outrank enlisted personnel. Commissioned officer pay grades are denoted O1-O10, warrant officer pay grades are denoted W1-W5, and enlisted pay grades are denoted E1-E9. Enlisted pay grades E5-E9 are reserved for enlisted personnel with some command authority. Individuals holding an enlisted pay grade of E5 or higher are known as non-commissioned officers. About 85% of military personnel have an enlisted pay grade.

[2]Maximum enlistment age and mandatory retirement age vary over time and by service branch.

Promotion criteria for enlisted personnel vary by pay grade. For the lowest four pay grades, promotion is primarily a function of current pay grade and military experience, though performance plays a minor role. For non-commissioned officers, however, promotion is a function of position availability, performance, military experience, and experience in current pay grade. Servicemen must have a minimum amount of military experience - which varies by pay grade - to be considered for promotion. Figure A.3 reports the active duty enlisted rank distribution by service branch for 2007. [3]

Pecuniary military compensation can be thought of as containing two components. The first and largest component of compensation - comprising on average over 90% of active duty pecuniary compensation - is base pay. The amount of base pay a serviceman receives is a function of his pay grade and military experience. Although base pay is adjusted annually by the Employment Cost Index, servicemen know with virtual certainty next year's base pay. Most servicemen, however, receive more than just base pay. Whether it be an enlistment bonus, combat pay, or extra pay associated with some other responsibility, this remainder is difficult to predict as it varies substantially year to year and person to person.

Individuals with at least 20 years of military service are eligible for a pension. The pension payments' size and starting date depend on the serviceman's active duty experience, reserve duty experience, retirement points, and pay grade. If active duty experience is at least 20 years, then pension payments begin upon retirement

[3] Defense Manpower Requirements Report, Department of Defense (2006)

from the military. But if military experience is at least 20 years and active duty experience is less than 20 years, then pension payments begin sometime between age 55 and age 60. Active and reserve duty experience determines how many retirement points a serviceman accumulates. A year of active duty earns 365 retirement points, while on average a year of reserve duty earns 77 retirement points.[4] The more retirement points earned during a career, the greater the eventual pension payment.

[4]Average annual reservist retirement point total based on information provided by Jeffrey Marmorstein, Operations Research Analyst, US Army Human Resources Command.

Chapter 3

Model

The model describes a man's career decision problem.[1] Each decision period the man receives civilian and military wage offers, which are determined by his civilian and military human capital. After receiving wage offers and preference shocks, the man, who is forward looking and utility maximizing, chooses which sector or sectors to participate in. As the man works in the civilian or military sector, he accumulates sector-specific human capital. The man can also accumulate human capital by acquiring education. The utility a man receives from entering or re-entering the civilian labor force depends on the realized business cycle state as well as his civilian sector wage. The following sections describe the model in detail.

[1]Including women in the model would increase computational complexity as it would require the inclusion of the female fertility decision. Furthermore, while women are eligible to join the military, over 90% of military participants in the data are male. For these reasons it was decided to exclude women from the model.

3.1 Primitives and Behavior

In the model, time is discrete. A decision period corresponds to an academic year (July 1 through June 31). Men begin making decisions at age 18. Decisions are made over a finite horizon with age 65 being the terminal period A. Let a denote a man's age.

3.1.1 Choice Set

Each decision period the man must choose which sector or sectors to participate in. The choice set includes six mutually exclusive options $K = \{c, s, at, h, cr, hr\}$. He may either work in the civilian sector c, attend school s, serve active duty military at, or stay home h. If an individual works in the civilian sector or stays home, he may also serve reserve duty military (cr or hr, respectively.) When a man joins the military in the model, he can only join the military's enlisted ranks. He cannot become a commissioned or warrant officer.[2]

In addition to the six options above, attending school and serving reserve duty military is a plausible choice and consequently was considered for inclusion in the choice set. However, in the data no one makes that choice. For this reason attending school and serving reserve duty military is excluded from the choice set.

[2]This restriction was imposed due to data limitations. See the appendix for more details.

3.1.2 Preferences

The man receives a utility reward from the choice he makes each decision period. If a man chooses k for the decision period corresponding to age a, he receives the reward function $R^k(S_a)$, where S_a is the man's state space at age a.

The man's reward for working in the civilian sector is a wage w_a^c plus a non-pecuniary component. The wage, which reflects the man's human capital, is given at age a by:

$$w_a^c = r^c \exp\{\beta_{0,c} + \beta_{1,c} g_a + \beta_{2,c}\chi_a^c + \beta_{3,c}\chi_a^m + \beta_{4,}\chi_a^{c\,2} + \beta_{5,c}\chi_a^c\chi_a^m + \varepsilon_a^c\}$$

where r^c is the civilian human capital rental rate, $\beta_{0,c}$ is a skill endowment, g_a is education attainment or highest grade level completed, χ_a^c is civilian experience, χ_a^m is military experience, and ε_a^c is a skill shock.

If a man did not work in the civilian sector last period, he then must pay a search cost for receiving a wage offer from the civilian sector. The cost's magnitude is determined by which business cycle state is realized that period. Higher search costs are associated with more difficulty finding a wage offer. Difficulty finding a wage offer, in turn, is positively correlated with the current business cycle's severity.[3]

Let d_a^k equal one if a man chooses k and age a and zero otherwise. The reward function for working in the civilian sector is the sum of the wage and search cost:

$$R^c(S_a) = w_a^c + \beta(1 - d_{a-1}^c)\sum_j \beta_j \mathbb{1}_{j_a}$$

[3]Kydland & Prescott (1982)

where j_a is the business cycle state.

If a man serves in the military, he receives a military wage. As stated previously, the military wage is base pay plus a remainder. To allow this remainder to vary by pay grade, military experience and relative to base pay, military wages are modeled as the following:

$$w_a^l = base(pg_a, \chi_a^m) \cdot r^l \cdot \exp\{\beta_{0,l} + \beta_{1,l} pg_a + \beta_{2,l} \chi_a^m + \varepsilon_a^l\}$$

where pg_a is pay grade, ε_a^l is a skill shock, and $l = \{at, r\}$. Notice that unlike the civilian sector, the military only values human capital that is obtained while in the military.

If a man serves active duty, his reward function consists of an active duty military wage as well as a non-pecuniary reward or cost:

$$R^{at}(S_a) = \beta_{at} + w_a^{at}$$

The utility obtained or lost from receiving tuition benefits, receiving health benefits, being deployed, etc. is included in the active duty non-pecuniary reward or cost.[4]

If a man serves reserve duty, he then receives the reward for what he did in the civilian sector - either working or staying home - as well as the reserve duty military

[4]It has been suggested that the model should incorporate a disutility associated with dying in combat. That is not necessary, however, because servicemen during the late 1970s and early 1980s were unlikely to think that they would die from combat. From 1980 through 2000, which includes the 1990-1991 Persian Gulf War, less than 1% of all military deaths were due to combat. Figure A.4, which was taken from a 2010 Congressional Research Service report, shows that from 1980 through 2000 less than 1000 servicemen died during a military deployment. For some individuals such as blacks, joining the military during this time actually decreased the probability of dying young. Additionally, individuals in the military during the late 1970s and early 1980s likely thought that the Vietnam War's outcome and the global politics of the time made a large American military deployment unlikely.

wage w_a^r and a non-pecuniary cost for participating in both sectors:

$$R^{cr}(S_a) = R_a^c + \beta_{cr} + w_a^r$$

$$R^{hr}(S_a) = R_a^h + \beta_{hr} + w_a^r$$

If a man chooses to increase his civilian sector human capital by attending school, he must pay a cost. Let $\mathbb{1}$ be an indicator variable whose value is one when the argument in the subscript is true and zero otherwise. The cost of attending school is given by:

$$R^s(S_a) = \beta_{0,s} - \beta_{1,s}\mathbb{1}_{12\leq g_a<16} - \beta_{2,s}\mathbb{1}_{16\leq g_a} - \beta_{3,s}(1 - d_{a-1}^s) + \varepsilon_a^s$$

where $\beta_{0,s}$ is a preference endowment, $\beta_{1,s}$ is the cost of attending college, $\beta_{2,s}$ is the cost of attending graduate school, $\beta_{3,s}$ is the psychic cost of entering or re-entering college given that the man did not attend school last period, and ε_a^s is a preference shock. It is assumed that college takes four years to complete and that graduate school can be attended indefinitely.

If a man does not work in the civilian sector, attend school, or serve active duty, then he stays home. The value of staying home is:

$$R^h(S_a) = \beta_{0,h} + \varepsilon_a^h$$

where $\beta_{0,h}$ is a preference endowment and ε_a^h is a preference shock.

The shocks $\varepsilon_a = \{\varepsilon_a^c, \varepsilon_a^s, \varepsilon_a^h, \varepsilon_a^{at}, \varepsilon_a^r\}$ are jointly normally distributed with mean zero and variance/covariance matrix Σ. It is assumed that the shocks are independently and identically distributed.

3.1.3 Military

The previous chapter briefly outlines how the military screens, promotes, and compensates its personnel. This section presents how the military's features are incorporated into the model.

Eligibility

The military imposes a maximum enlistment age and a mandatory retirement age. Since these restrictions vary over time and by service branch, a "rule of thumb" is established in the model. The model requires that a man must retire from the military after 30 years of service and cannot enlist after age 24.[5]

The AFQT scores reported in the data are from an ASVAB that was administered to all survey participants in 1979. These AFQT scores were collected as survey data only and were not used for enlistment qualification. Consequently, survey participants had no incentive to perform well. Furthermore, some survey participants were as young as age 14 at the time of the test. Consequently, some military participants in the data have reported AFQT scores that place them below

[5] In reality the maximum enlistment age ranges in the mid to late 30s. In the data, however, no one joins the military after age 24. Consequently, 24 was chosen as the maximum enlistment age.

the military's enlistment qualification standards.[6] To account for military policies as well as the data, in the model high school graduates who have not already enlisted and have an AFQT score in the lowest quartile qualify for military enlistment with probability π_m, while men who have not already enlisted, have no high school diploma, and have an AFQT score below the median qualify for military enlistment with probability π_d. If a man does not qualify for enlistment, all military options are removed for his choice set. Qualification for enlistment is reevaluated each decision period.

Promotion

Recall that promotion for non-commissioned officers is a function of current pay grade, position availability, performance, military experience, and experience in current pay grade. Performance and position availability, however, are not observed in the data. Consequently, in the model promotion probabilities for all pay grades are a function of current pay grade and military experience only. The model also reflects actual promotion criteria in that servicemen must have a minimum amount of military experience - which varies by pay grade - to be considered for promotion. Since it is extremely rare, the model prohibits pay grade demotion and multiple annual pay grade promotions.

[6]Recall from the previous chapter that by law the military cannot enlist individuals with an AFQT score in the lowest decile and only 25% of enlistees may have an AFQT score in the second and third deciles. Additionally, high school dropouts must have an AFQT score that exceeds a cutoff value, which is usually around the median.

When an individual joins the military, he receives a pay grade of E1 and attends basic training. The military usually promotes individuals after they complete basic training. Some individuals with certain pre-enlistment activities or achievements are promoted from E1 to E3 or E4 instead of from E1 to E2. This occurs roughly among 10% of servicemen in the data. Unfortunately, the data do not contain information regarding which men have these activities or achievements. In the model servicemen are promoted from E1 to E3 or E4 with a probability that is taken from the data.

Base Pay

The amount of base pay a serviceman receives is a function of his pay grade and military experience. Base pay takes the following form in the model:

$$base(pg_a, \chi_a^m) = \beta_{0,b} + \beta_{1,b} pg_a + \beta_{2,b} \chi_a^m$$

Retirement

Recall that individuals with at least 20 years of military service are eligible for a pension. In the model active duty retirees start receiving pension payments the year they retire. Reserve duty retirees start receiving pension payments at age 60.[7] Pension payments are calculated using the military's pension payment formula:

$$pension(pg_a, \chi_a^m) = base(pg_a, \chi_a^m) \cdot \left(\frac{points}{365}\right) \cdot 0.025$$

[7]Military reservists can lower the age at which pension payments begin to as low as age 55 by serving certain types of duty. Unfortunately, these types of duty cannot be observed in the data. In the model it is assumed that the retirement age for reservists cannot be lowered from age 60.

where *points* is the retirement point total. The formula calculates military experience in years and then awards 2.5% of the veteran's highest base pay for each year served. At most a veteran can receive 75% of base pay.

3.1.4 Business Cycle State Transitions

During each decision period men make choices given the current business cycle state. It is necessary, therefore, to model how the business cycle evolves over time. Annual aggregate unemployment is used to approximate the current business cycle state. It is assumed that aggregate unemployment follows an AR1 process. Transition probabilities between discrete aggregate unemployment states are constructed as in Tauchen (1986) by discretizing the AR1 process into a Markov chain. It is assumed that everyone knows the transition probabilities. It was determined that two business cycle states are sufficient to capture the variation in the civilian sector search cost.

3.1.5 Initial Conditions and State Space

At age 18 a man is characterized by his race ($race$), AFQT quartile score ($afqt$), education attainment (g_{18}), initial pay grade (pg_{18}), and endowment of skills and preferences across sectors ($\beta_0 = \{\beta_{0,c}, \beta_{0,s}, \beta_{0,h}, \beta_{0,at}\}$). It is assumed that at age 18 the man possesses no civilian or military experience and attended school last decision period. As the man makes choices each decision period, his state space evolves. If a man chooses to work in the civilian sector, he gains a year of civilian experience ($\chi^c_{a+1} = \chi^c_{a+1} + d^c_a + d^{cr}_a$). In order to award the correct pension payment and pension starting date, it is necessary to differentiate between active duty and reserve duty military experience. Consequently, if a man chooses to serve active duty, he gains a year of active duty experience ($\chi^{at}_{a+1} = \chi^{at}_{a+1} + d^{at}_a$) and if he chooses to serve reserve duty, he gains a year of reserve duty experience ($\chi^r_{a+1} = \chi^r_{a+1} + d^{rc}_a + d^{rh}_a$). Military experience is given as the sum of active duty and reserve duty experience ($\chi^m_a = \chi^{at}_a + \chi^r_a$). Education attainment evolves if the man chooses to attend school ($g_{a+1} = g_a + d^s_a$). Pay grade and business cycle state evolve probabilistically as previously mentioned. Race, AFQT quartile score, and skill and preference endowments do not evolve. Preference and skill shocks are also in the state space, which is given at age a by:

$$S_a = \{a, \beta_0, \chi^c_a, \chi^{at}_a, \chi^r_a, g_a, pg_a, race, afqt, d^k_{a-1}, \varepsilon_a\}$$

Unobserved Heterogeneity

To further enrich individual heterogeneity, a finite number of types are introduced. Skill and preference endowments are allowed to vary across types. The probability of being a certain type is conditioned on education level at age 18, race, and AFQT quartile score.[8] Only individuals know their type.

[8] It is true that grade level at age 18 is an endogenous decision (i.e., parents decide when their children enter school and consequently what their grade level will be at age 18). Unfortunately, modeling grade level at age 18 as endogenous would be computationally difficult and would require unavailable parental decision information. Consequently, it is assumed that conditional on endowments, grade level at age 18 is exogenous.

3.1.6 Race and Rental Prices

For black men in the model, the civilian wage offer includes an additional term $\beta_{b,c}$. For black men the civilian wage offer takes the following form:

$$w_a^c = r^c \exp\{\beta_{0,c} + \beta_{b,c} + \beta_{1,c} g_a + \beta_{2,c}\chi_a^c + \beta_{3,c}\chi_a^m + \beta_{4,}\chi_a^{c\,2} + \beta_{5,c}\chi_a^c\chi_a^m + \varepsilon_a^c\}$$

The additional term has two possible associations. If associated with the human capital rental rate r^c, $\beta_{b,c}$ reflects the value the civilian sector places on black civilian sector skills relative to white civilian sector skills. If negative in sign and associated with the human capital rental rate, $\beta_{b,c}$ is a measurement of racial discrimination in civilian sector wage offers. However, if associated with the skill endowment $\beta_{0,c}$, then $\beta_{b,c}$ reflects racial differences in the civilian sector skill endowment. To what extent $\beta_{b,c}$ is associated with each term is ambiguous.[9] Since it is assumed that the military cannot racially discriminate, a similar racial term is not included in black military wage offers.

3.1.7 Updating Choice Set and State Space

Before making his choice each decision period, the man updates his eligible choice set and completes updating his state space. After these updates each man makes his choice.

[9] Keane & Wolpin (2000)

Choice Set

Each man's eligible choice set evolves over time. Consequently, each man must update his choice set at the begining of each decision period by determining whether he is eligible for military service or school attendance. As mentioned previously, men possessing no high school diploma and/or a low AFQT score are barred from entering military service with some probability. If a man has left military service, is over age 24 and is not in the military, or has served 30 years in the military, the military is removed from his choice set. Additionally, individuals over age 30 are prohibited from attending school. These sector restrictions can limit the choice set to as few as two options. [10]

State Space

When a man enters a new decision period, he updates his state space. From last decision period's choice the man knows how his civilian experience, military experience, and education attainment evolve. Additionally, the man learns at the beginning of each decision period the current business cycle state, whether he was promoted last period (if he served in the military), and the values of that decision period's skill and preference shocks.

[10] In reality retired veterans sometimes re-enter the military and some men over age 30 attend school. However, in the data both events occur very rarely. Consequently, for the sake of data fit, the schooling and military re-entry restrictions are imposed on the choice set.

3.1.8 The Man's Problem

Men maximize their present discounted expected utility over a finite horizon. Letting δ be the discount factor and K_a the choice set at age a, the value function at age a is:

$$V(S_a) = \max_{d_a^k} E\left[\sum_{i=a}^{A} \delta^{A-a} \sum_{k=1}^{K_a} R_a^k d_a^k | S_a\right]$$

The value function can also be written as the maximum over choice-specific value functions as in Bellman (1957).

Final Decision Period Problem

Since every man retires after age A, the man's problem at age A is different from all previous decision periods. More specifically, when making his choice in the final decision period, each man considers only the utility he receives that period. There is no need to consider how the decision period's choice will affect future decision period utilities since there are no future decision periods. Consequently, at age A the man's choice simply maximizes over the reward functions:

$$V(S_A) = \max_{k \in K_A} [R^k(S_A)]$$

Not Final Decision Period Problem

If a man is younger than age A, however, his problem is very different from the final decision period problem. In addition to the utility he receives in the current decision period, the man's choice must now also consider how it impacts expected utility in future decision periods. This consideration exists because the current decision period's choice will affect future human capital. Furthermore, the current decision period's choice can alter future choice sets and military pension eligibility.

If $a < A$, the current decision period's choice maximizes the utility received this decision period plus the discounted expectation of the next decision period's value function given the current decision period's choice. The decision period's value function is an expectation because future shocks and choices have not been realized. The man also weights the future by business cycle transition probabilities and promotion probabilities. For $a < A$, the man's value function can be written as:

$$V(S_a) = \max_{k \in K}[V^k(S_a)]$$

where $V^k(S_a))$ is:

$$V^k(S_a) = R_a^k + \delta \sum_j \pi_{j_{a+1}|j_a} E\left[V(S_{a+1})\,|S_a, d_a^k = 1\right]$$

where $\pi_{j_{a+1}|j_a}$ is a business cycle transition probability. If a man is serving in the military, there is a possibility that he will be promoted at the end of the period. When promotion is possible, $V^k(S_a))$ is:

$$\begin{aligned} V^k(S_a) = R_a^k + \delta \sum_j \pi_{j_{a+1}|j_a} [\pi_{pg_{a+1}} E[V(S_{a+1})\,|S_a, d_a^k = 1] \\ + (1 - \pi_{pg_{a+1}}) E[V(S_{a+1})\,|S_a, d_a^k = 1]] \end{aligned}$$

where $\pi_{pg_{a+1}}$ is a promotion probability. However, if a man is not serving in the military and there is a probability that he may not qualify for military service in the next period, the discounted expectation of the next period's value function is weighted by the probability that the military may not be in the man's choice set in the next decision period. Depending on the reason for disqualification, $V^k(S_a))$ is either:

$$V^k\left(S_a\right) = R_a^k + \delta \sum_j \pi_{j_{a+1}|j_a}[\pi_d E[V\left(S_{a+1}\right)|S_a, d_a^k = 1]$$
$$+ (1-\pi_d)E[V\left(S_{a+1}\right)|S_a, d_a^k = 1]]$$

or:

$$V^k\left(S_a\right) = R_a^k + \delta \sum_j \pi_{j_{a+1}|j_a}[\pi_m E[V\left(S_{a+1}\right)|S_a, d_a^k = 1]$$
$$+ (1-\pi_m)E[V\left(S_{a+1}\right)|S_a, d_a^k = 1]]$$

3.2 Solution Method

Starting at the terminal period the model is solved using backward recursion. This section outlines the recursion process and describes how certain expectations critical to the solution method are approximated.

First, consider the man's problem at age A. As stated in the previous section, at age A each man's choice maximizes over the set of eligible reward functions given his state space position S_A. Consequently, knowing the reward functions and S_A is sufficient to solve for a man's choice at age A.

At age $A-1$, however, the man's choice maximizes over the reward function plus the discounted expectation of age A's value function given S_{A-1} and his choice at age $A-1$. Therefore, in order to solve the man's problem at age $A-1$ the expected value function at age A must be calculated for every eligible choice $k \in K$. This expectation is a multivariate integral and takes the form:

$$\begin{aligned} & E\left[\max\left[R^1\left(S_A\right),\ldots,R^K\left(S_A\right)|\bar{S}_{A-1},d^k_{A-1}=1\right]\right] = \\ & \int\cdots\int \max\left[R^1\left(S_A\right),\ldots,R^K\left(S_A\right)|\bar{S}_{A-1},d^k_{A-1}\right] \\ & \quad \cdot f\left(\varepsilon_c,\varepsilon_s,\varepsilon_h,\varepsilon_r,\varepsilon_{at}\right) d\varepsilon_c d\varepsilon_s d\varepsilon_h d\varepsilon_r d\varepsilon_{at} \end{aligned} \tag{3.2.1}$$

Taken over the shock distribution, (3.2.1) calculates the expected maximum reward function value at age A given $\bar{S}_{A-1}$ and the choice k.[11] Since the reward functions and shock distribution are known, (3.2.1) can be calculated. Notice that for every realization of $\bar{S}_{A-1}$ and k, (3.2.1) takes a different value. Therefore (3.2.1) must be calculated for every realization of $\bar{S}_{A-1}$ and k.

The solution problem at age $A-2$ is similar to the problem at age $A-1$ in that the man maximizes over the reward function plus the discounted expectation of age $A-1$'s value function given S_{A-2} and his choice at age $A-2$. However, at $A-2$ the expectation of $A-1$'s value function contains more than the reward functions at age $A-1$:

$$E\left[\max\left[V^1\left(S_{A-1}\right),\ldots,V^K\left(S_{A-1}\right)|\bar{S}_{A-2},d^k_{A-2}=1\right]\right] \tag{3.2.2}$$

Fortunately, since the previous period's problem is solved, $V\left[S_{A-1}|\bar{S}_{A-2},d^k_{A-2}=1\right]$ can be calculated for any $\bar{S}_{A-2}$, k, and ε_{A-1}. Consequently, (3.2.2) can be calculated.

[11] $\bar{S}_a$ is S_a excluding ε_a.

The recursive process outlined above is used to solve the man's problem from age $A-1$ to the first decision period at age 18. For each age a, the following expectation must be solved for every S_a and k:

$$E\left[\max\left[R^1\left(S_{a+1}\right),\ldots,R^K\left(S_{a+1}\right)|\bar{S}_a,d_a^k=1\right]\right] \tag{3.2.3}$$

Unfortunately, (3.2.3) is a multivariate integral that does not have a simple analytical solution. Consequently, for every feasible point in the state space, Monte Carlo integration is used to compute (3.2.3). First, Y draws of ε are taken from the shock distribution. Second, (3.2.3) is evaluated at each choice k for each shock draw $y \in Y$. Third, for each $y \in Y$, the maximum evaluation across k is determined. Lastly, the maximum evaluations are summed across y and then divided by Y - providing an average maximum evaluation. The average maximum evaluation is used to approximate (3.2.3).

Chapter 4

Data

The data are from the 1979 cohort of the National Longitudinal Survey of Youth (NLSY79), military pay tables, and the Bureau of Labor Statistics. The NLSY79 tracks 12,686 individuals who ranged in age from 14 to 22 when they were first interviewed in 1979. The NLSY79 interviews were conducted annually from 1979 though 1993. From 1994 to the present, interviews have been conducted biennially. During a NLSY79 interview, information from the previous interview date to the present is gathered. Fortunately, enough data were gathered in 1979 that some variable histories can be constructed as far back as 1975.

A rich data source, the NLSY79 contains detailed information on demographics, civilian labor force participation, and education attainment. During the initial interview each individual's age, sex, and race were recorded. For each week, individuals in the NLSY79 report hours worked at all civilian jobs. Individuals are also asked to report civilian "wages, salary, commissions, or tips from all jobs, before deductions for taxes or anything else" for each calendar year. For education attainment, the survey annually records the highest grade completed as of May 1.

In addition to civilian data, the NLSY79 gathers military information. Multiple survey questions are devoted to military enlistment and separation. During each interview, individuals are asked if they have joined the military since their last interview. If an individual indicates that he did join the military, he is then asked what month and year he joined. The individual is also asked what service branch he joined. While in the military, individuals are asked various questions regarding their compensation, benefits, position, training, etc. For each calendar year, individuals are asked to report all military wages before any deductions. When reporting military wages, individuals are reminded to include all "money received from special pays, allowances, and bonuses." Each serviceman is also asked to report his current pay grade. If an individual indicates that he left the military, the month and year he left are recorded.

The NLSY79 administered the ASVAB to both civilian and military survey participants. As mentioned previously, the ASVAB administered by the NLSY79 was not used for military qualification and no performance reward was offered. Survey respondents had no incentive, therefore, to perform well and consequently may not have exerted their best effort. Additionally, the NLSY79 administered the ASVAB to some respondents who had not yet become of military enlistment age. AFQT scores reported in the NLSY79 are calculated from the NLSY79 ASVAB results.

Of the 12,686 individuals tracked in the NLSY79, 6,111 individuals (3,003 male) form the nationally representative cross-sectional sample. In addition to the cross-sectional sample, the NLSY79 contains several over-samples. 5,295 individuals belong to over-samples of blacks, Hispanics, and economically disadvantaged whites. 1,280 individuals (824 male) belong to a military over-sample. All individuals in the military over-sample served active duty in 1979. Due to budget cuts, the military over-sample was reduced to 201 individuals in 1985.

Data were taken from two sources in addition to the NLSY79. Annual aggregate unemployment data were obtained from the Bureau of Labor Statistics. In addition to the military wage data reported in the NLSY79, military base pay data were acquired. The military makes annual base pay tables publicly available. The tables report base pay as a function of pay grade and military experience. Base pay tables from 1975 through 2004 were obtained.

The analysis sample contains 3,711 males: 2,896 males from the cross-sectional sample and 815 males from the military over-sample. Everyone in the analysis sample was tracked each academic year from age 18 until 2005 or until a gap appeared in their data. There are 66,456 observations.

Using NLSY79 data, the following variables were constructed for each observation: age, education attainment, civilian experience, active duty experience, reserve duty experience, military pay grade, previous decision period choice, civilian wage, military wage, and sample weight.[1] Race and AFQT quartile score were also taken from NLSY79 data. Annual aggregate unemployment for each observation is entered from the Bureau of Labor Statistics data. Then using the cutoff value determined by the discretization of the annual aggregate unemployment data, each observation's annual aggregate unemployment value is mapped into a business cycle state value. Estimated base pay for each observation is calculated from a base pay regression that uses military base pay table information.

Due to data gaps, by 1984 the analysis sample's military over-sample component drops from 815 to 642. The NLSY79 military over-sample reduction in 1985 removes 504 individuals from the analysis sample, 149 of whom were still in the military in 1984.

Unlike the cross-sectional sample weights, the military over-sample weights were not constructed to scale up to the national population. Rather, the military over-sample weights scale up to the national active duty military population. The opposing weighting structures create a combined sample that does not scale up to the national population. To correct this, military over-sample weights were modified along with the weights of men in the cross-sectional sample who served active duty military in 1979.[2]

[1]Variable construction details are provided in the appendix.

[2]Let γ_{79} be the sum of weights for cross-sectional sample men who served active duty military in 1979 and γ_m be the sum of weights for the military over-sample. The weights for these men were modified by multiplying them by $\frac{\gamma_{79}}{\gamma_{79}+\gamma_m}$.

4.1 Descriptive Statistics

Tables A.1 through A.6 display various descriptive statistics. Table A.1 reports general descriptive statistics for the analysis sample. Table A.2 reports the nationally representative sample's choice distribution, while Table A.3 reports the nationally representative sample's choice transition probabilities. Tables A.4 and A.5 contain high school completion by race and enlistment status and Table A.6 contains civilian and military wages by age. Figure A.5 displays annual aggregate unemployment from 1960 through 2004.

Table A.1 reports general descriptive statistics for the analysis sample both collectively and by race. On average a man is observed for just under 23 years. The average age for each observation is just under 29 years old. Both statistics vary little by race, which suggests that sample attrition is not greatly influenced by race. Since relatively few men join the military, average active and reserve duty experience for the entire analysis sample are both relatively low (0.6 and 0.12 years, respectively). However, when confined to just men in the military, average active and reserve duty experience jumps to 3.3 and 5.3 years, respectively. The typical observation has just less than 7 years of civilian experience.

Approximately 28% of the analysis sample joins the military at some point. This statistic may be somewhat deceiving, however, since it includes both the nationally representative sample and the military over-sample. Excluding the military over-sample, 9.6% of the analysis sample joins the military at some point. For those in the military, the average pay grade is E3 or E4.

Table A.1 reveals several racial differences in the data. Blacks join the military at a much higher rate than whites.[3] In the analysis sample, 39.2% of blacks and 26.2% of whites join the military. Again this statistic is deceiving, however, since it includes both the nationally representative sample and the military over-sample. Excluding the military over-sample, 12.3% of blacks and 9.34% of whites join the military at some point. On average, blacks have 1.5 fewer years of civilian experience and an AFQT score 30 points lower than whites. When in the military, blacks stay over a year longer on average and have a higher average pay grade than whites.

When attempting to construct a model that describes the incentives and disincentives individuals associate with various choices, it is important to understand individuals' choice distribution. Table A.2 reports the choice distribution by age for the nationally representative component of the analysis sample. There are several trends in the choice data. At age 18 about a quarter of men choose to work in the civilian sector. As men age, however, their representation in the civilian labor force increases. By age 21 the proportion of men in the civilian workforce doubles to about 50%. Around age 24 the rate of increase in the proportion of men in the civilian workforce drops to under 5%. By age 30 about 84% of men work in the civilian sector.

The school attendance and home sector participation trends are opposite the civilian sector participation trend. At ages 18 and 19 many individuals are either

[3]Hispanics are reported with whites.

completing high school or starting college. Consequently, the school attendance rate is at its highest at ages 18 and 19. Over time, students either drop out or receive their degree or diploma. By age 24 just over 6% attend school, while at age 30 less than 1.5% attend school. From age 18 to 20 a surprisingly large number of men stay home despite the other available choices. At age 18 about 32% of men stay home, while at age 20 about 23% of men stay home. The stay home rate continues to decrease during the early to mid 20s. At age 22 and beyond, more men stay home than attend school. After age 25 the stay home rate stabilizes around 14%.

Unlike the other choice trends, both the active and reserve duty choice trends rise, peak, and then decline. Most men who join the military do so between age 18 and 20 and stay four to five years. This results in peak active duty participation around age 20 and 21. The active duty participation rate starts at about 2.2% at age 18. By age 20, active duty participation has climbed over 210%, to 4.7%. After age 24 active duty participation decreases dramatically and by age 30 active duty participation is under 1%. Although much lower than active duty participation, reserve duty participation exhibits the same general trend. Reserve duty participation starts at 1% at age 18 and peaks a few years later at 1.6% at age 22. By age 26, reserve duty participation is under 1%. Notice that when compared to other choices, the military participation rates are relatively low.

It is important to understand how individuals transition between choices. Table A.3 reports sector transition rates for the nationally representative sample. All choices persist significantly, with working in the civilian sector and serving active duty having the greatest persistence at 91% and 85%, respectively. Once an individual starts working in the civilian sector, he is very unlikely to transition into anything else. Transitions from the civilian sector to school or to the military are under 1% each. At 7.5%, staying home is the second highest transition rate for men in the civilian sector. Student transition rates are most broadly distributed across choices. 27% of students transition to the civilian sector, while 18% transition to home. School attendance persists at a rate of 53%. About 2% of students transition into the military. Most men who stay home continue to do so. About 40% of home participants transition to the civilian sector. Men serving on active or reserve duty tend to stay in the military. For those leaving active duty, about 64% transition to home, while about 30% transition to the civilian sector. When leaving the reserves, most men enter the civilian sector.

As mentioned previously, the military limits how many high school dropouts it can recruit. During the mid to late 1970s, the military was learning what information signaled that a volunteer would likely perform poorly in the military. Figure A.6 shows that high school dropouts - including dropouts who possess a General Education Diploma, or GED - are more likely to leave the military within 24 months of enlistment. Consequently, in the early 1980s the military decided to further restrict how many high school dropouts it recruited. This reform occurred while the NLSY79 sample was of military enlistment age.[4]

[4]Committee on the Youth Population and Military Recruitment (2003)

Given military recruitment policy, which restricts high school dropout enlistment and which changed during sample collection, and racial differences in education attainment, it is important to understand who graduates from high school. Table A.4 displays high school diploma status for the nationally representative sample by race, while Table A.5 displays high school diploma status for the nationally representative sample at time of enlistment. Table A.4 shows that blacks graduate high school at a lower rate than whites. At age 19 the high school diploma gap is at its worst at about 17%. At age 20 and above, however, the high school diploma gap shrinks to about 12%. When introducing unobserved skill and preference heterogeneity into the model, Table A.4 supports conditioning type probabilities by high school diploma status and race. Including both variables in the type probability determination allows the estimation process to disentangle the effects these variables have on unobserved skill and preference endowments.

Turning attention to high school diploma status at time of enlistment as reported in Table A.5, it is difficult not to notice that a large difference exists between the diploma status of those who enlist at age 18 and those who enlist later. Just under 60% of men who enlist at age 18 possess a high school diploma, while about 88% of men who enlist at age 19 or older possess a high school diploma. There are several possible explanations for this difference. It could be that shifts in military recruitment policy during the sample collection period are responsible. Rather, it could be that high school dropouts at age 18 see little utility in other sectors and therefore join the military in particularly large numbers. The difference could also be explained by the fact that the sample's proportion of high school graduates rises over time, and consequently, older first-time enlistees are more likely to possess a diploma. Whatever the explanation, Table A.5 shows that relative to high school graduates, high school dropouts are very attracted to military service.

Table A.6 reports mean military and civilian wages by age. Wages increase as men accumulate education, civilian experience and military experience over time, although the rate of increase varies. From age 18 through 27, wages for civilian sector workers rise 236%, while wages for men serving active duty and reserve duty rise 230% and 251%, respectively. Regardless of which age is considered, the civilian wage is greater than the active duty wage, which is greater than the reserve duty wage.

As men age, the gap between civilian and military wages increases. At age 18, the mean active duty wage is 88% of the mean civilian wage. By age 20 - when military participation is at its highest - the percentage has deteriorated to 85%. For men age 24, the gap between civilian and military wages is 83%. Finally, by age 35 the percentage has deteriorated to just under 78%.

Figure A.5 reports the United States' annual aggregate unemployment rate from 1950 through 2007.[5] The graph reveals that the aggregate unemployment rate during the early 1980s was very high. Furthermore, except for 1978 and 1979, the annual aggregate unemployment rate from 1975 through the mid 1980s was rela-

[5]Bureau of Labor Statistics (2010)

tively high. During the mid 1990s, however, the annual aggregate unemployment rate is relatively low.

The relatively high annual aggregate unemployment rates of the late 1970s and early 1980s have implications for the model's discretization of the business cycle. Recall that annual aggregate unemployment is used to approximate the business cycle. In the model most men make the military participation decision between age 18 and 21. Furthermore, in the data most men are between age 18 and 21 during the late 1970s and early 1980s. Business cycle variation during the late 1970s and early 1980s, therefore, most directly affects military participation in the data. When discretizing the business cycle, not enough variation exists during the late 1970s and early 1980s to have more than two business cycle states. If more states are added, the best business cycle states are not realized in the data until the mid 1990s. By the mid 1990s, however, every man in the data has made his military participation and education attainment decisions. Consequently, modeling two business cycle states is sufficient because it adequately captures business cycle variation when men in the data are making their military participation and education attainment decisions.

4.2 Capturing Data Trends

Tables A.2 and A.3 reveal that the data contain significant age and transition trends. It is important to allow the model to distinguish these trends from unobserved heterogeneity. Otherwise, the degree of unobserved heterogeneity may be overstated. To capture these trends, age trend parameters were added to the schooling and stay-home reward functions R_a^s and R_a^h, an age 18 non-pecuniary utility parameter was added to the reward for serving reserve duty and staying home, and persistence parameters were added to almost all reward functions.[6]

[6] The appendix contains a complete description of functional forms, including all trend capturing parameters.

Chapter 5

Estimation

5.1 Estimation Method

There are several considerations when estimating the model. In addition to men's choices, men's wages are observed as an outcome in the data. Furthermore, observed wages are measured with error. Type heterogeneity must be incorporated into the estimation method. This section presents the estimation method, explains how the considerations above are addressed in the estimation method, and presents how standard errors are calculated.

Likelihood function maximization is used to estimate the model. Due to the shocks' serial independence, the likelihood function can be written as the product of within-period outcome probabilities across men:

$$L(\theta|X) = \prod_{i=1}^{N} \left(\sum_{t=1}^{T} \pi_t \prod_{a=18}^{A_i} \mathbb{P}\left[O_a|\bar{S}_{a,i}, t\right] \right)^{wt_i}$$

where $O_a = \{d_a^k, w_a^{k,o}\}$ is the outcome at age a, $w_a^{k,o}$ is the observed wage, X is the data, θ is the parameter vector, N is the sample size, A_i is the oldest age at which individual i is observed, wt_i is an individual's sample weight, π_t is the probability of being type t, and T is the number of types. If a wage is not observed, the outcome at age a is just the man's choice d_a^k.

It is assumed that there exists within the data a finite number of heterogeneous types. Skill and preference endowments vary across types. It is not known what type each man belongs to because types are not observed. Instead, the probability of being a certain type conditional on possessing certain observable characteristics is estimated.

Type probabilities π_t are parameterized using a multinomial logit model. Let Z be a 1×5 vector containing a high school diploma status at age 18 indicator, a race indicator, and AFQT quartile score indicators and let γ_t be a 5×1 vector containing five parameters. For all types greater than one, the multinomial logit takes the form:

$$\pi_t = \mathbb{P}\left(type = t \neq 1\right) = \frac{\exp\left\{\gamma_{0,t} + \gamma_t Z\right\}}{1 + \sum_{t=2}^{T} \exp\left\{\gamma_{0,t} + \gamma_t Z\right\}}$$

for type one, the multinomial logit takes the form:

$$\pi_t = \mathbb{P}\left(type = 1\right) = \frac{1}{1 + \sum_{t=2}^{T} \exp\left\{\gamma_{0,t} + \gamma_t Z\right\}}$$

When a man works in the civilian sector or serves in the military, a wage is usually observed. After examining the civilian and military wage data, however, it becomes clear that wages are measured with error.[1] For choice k it is assumed that the measurement error takes the following multiplicative form:

$$w_a^{k,o} = w_a^k \cdot \exp\{\eta_a^k\} \tag{5.1.1}$$

where w_a^k is the model's wage offer, $w_a^{k,o}$ is the observed wage, and η_a^k is a shock distributed $N(0, \sigma_{\eta_k}^2)$. $E[\varepsilon_k \eta_k] = 0$.

Suppose the outcome at age a is comprised of choice k and an observed wage. The probability of observing that outcome is given by:

$$\mathbb{P}\left(d_a^k = 1, w_a^{k,o} | \bar{S}_a\right) = \int_{w_a^k} \mathbb{P}\left(d_a^k = 1 | w_a^k, \bar{S}_a\right) \cdot \mathbb{P}\left(w_a^{k,o}, w_a^k | \bar{S}_a\right) \tag{5.1.2}$$

The outcome probability is an integral over the model's wage offer as the wage offer is not observed in the data. The integral is calculated using Monte Carlo integration. Y draws are taken of ε.[2] The kernel's first term is the probability of choosing k given $\bar{S}_a$ and is calculated using a smoothing simulator.[3] The kernel's second term is the joint probability of observing both the wage offer and the observed wage. For each draw $y \in Y$, the kernel is calculated as the product of its two terms. The

[1]For example, some active duty military participants with multiple years of military experience report an annual wage below $1,500. Given military pay tables, such wages are unrealistic. Additionally, several individuals with 15 plus years of civilian experience report an annual civilian wage under $1,000.

[2]The relationship described in (5.1.1) implies that given $w_a^{k,o}$ and ε_a^k, η_a^k can be solved for.

[3]Let τ be the smoothing parameter, which is set to 500. As in Eckstein & Wolpin (1999), for each draw of ε, the kernel's first term is:

$$\exp\left[\frac{V^k_{d_a^k=1}(S_a) - max[V^k(S_a)]}{\tau}\right] \Bigg/ \sum_k \exp\left[\frac{V^k(S_a) - max[V^k(S_a)]}{\tau}\right]$$

integral is calculated as the kernel's average over Y draws. If an outcome does not include an observed wage, then (5.1.2) reduces to $\mathbb{P}\left(d_a^k = 1|\bar{S}_a\right)$ and is calculated using just the smoothing simulator as described above.

Identification of the wage parameters and wage error variances comes from the wage and choice data. The measurement error variances are identified by the wage data and assumptions on the measurement errors' distributional forms. The schooling and home parameters as well as the non-pecuniary civilian employment and military parameters are identified by the choice data.

All military wage offers in the model are a function of military base pay. Thus, the model requires knowing the base pay of every current and potential serviceman. Military base pay, however, is not reported separately from total military pay in the data. Using military pay table data, base pay for every man is estimated by ordinary least squares or OLS regression with pay grade and military experience as the exogenous variables. With an R^2 value of 0.93, the OLS regression fits the base pay data well.

Standard errors for the parameter estimates are calculated using the BHHH estimator. The BHHH estimator does not require taking a second derivative, which would be difficult to calculate given the likelihood function's form.[4] Let P be the number of parameters. The BHHH estimator takes the following form:

$$[I(\theta)]^{-1} = \left[\sum_{i=1}^{N} g_i g_i'\right]^{-1} \tag{5.1.3}$$

[4]Greene (2008)

where for individual i, g_i is the following $P \times 1$ vector:

$$g_i = \frac{\partial \ln L\left(x_i, \theta\right)}{\partial \theta}$$

The standard errors are the diagonal terms in (5.1.3).[5]

5.2 Simulation

After the model is estimated it is used to simulate choice behavior under current policies as well as under counterfactual policies. This section describes how simulations are conducted.

The first step in conducting a simulation is creating the simulation participants' initial state space positions. Ideally, the choices of simulation participants reflect the choices that men in the data would make. Consequently, when it comes to the attributes that drive decision making (i.e., the initial state space positions), the simulation participants' distribution should be the same as the data's distribution. To achieve this result, the initial state space of every man in the data is used to create the initial state space of 40 simulation participants. In total 148,440 simulation participants are created and - for the initial state space's observable components - the data and simulated participant distributions are equal.

Creating simulation participants from the data does not ensure that the initial state space distributions are identical because not all of the state space is observed in the data. Endowment type is not observed in the data and initial pay grade is

[5] Standard errors are reported with the parameter estimates in the appendix.

not always observed in the data.[6] Consequently, before simulating behavior, each simulation participant needs an endowment type and an initial pay grade. Using the estimated endowment type probabilities, which are conditioned on observable components of the initial state space, each simulation participant is given an endowment type. Initial pay grades are assigned using the initial pay grade distribution observed in the data.

After initial state space positions are constructed for the simulation participants and the model is solved,[7] choices are simulated. Starting at age 18, each decision period, each simulation participant receives a draw from the shock distribution and then chooses from his available choice set. After making his choice, each simulation participant receives his reward and learns how his state space and choice set evolve.[8] As simulation participants move through the model, their decisions and state space positions are recorded. When simulation results are reported, only results for simulation participants generated from the nationally representative sample are included.[9]

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[6]For men who join the military at age 18, initial pay grade is observed. However, for all other men it is not known what pay grade they would enter the military with because they have not been observed in the military.

[7]See Chapter Three to learn how the model is solved.

[8]That is, what experience and grade level he obtains, what next period's business cycle state will be, whether he is promoted (provided that he is in the military), and whether he qualifies for military service.

[9]Only results for simulation participants generated from the nationally representative sample are reported because the study is interested in how the simulated counterfactual experiments impact the national population.

5.3 Model Fit

This section describes model fit and compares the simulation results to the nationally representative sample. Overall, the model fits the data reasonably well.

Table A.7 contains the simulation's choice distribution. The simulation successfully matches each choice's temporal trend. Predicted civilian sector participation increases steadily over time and eventually reaches around 84%. School attendance peaks at age 18 and then decreases steadily to just under 6% at age 24. By age 30, 2.5% of men are predicted to be in school compared to 2% in the data. Predicted home participation decreases over time. The simulation slightly over-predicts or under-predicts home participation between age 22 and 26.

Although military participation is a relatively low proportion of the data, the model does a good job fitting the military choice trends and participation rates. As in the data, simulated active duty participation is relatively high at age 19 through 22 and then quickly declines. In the simulation, however, active duty participation does not peak as high and dissipates less quickly than in the data. Though peaking two years after the data, the simulation's reserve duty participation trend also fits the data well.

Table A.8 presents yearly goodness of fit statistics for the choice distribution. Calculated using the likelihood-ratio test, these statistics provide a way to test whether the simulated choice distribution is consistent with the data's choice distribution. Pearson's chi square test was considered for calculating the goodness of fit statistics. Unfortunately, when the frequency of some choices is relatively low, Pearson's chi square test statistic no longer follows a chi square distribution. Consequently, it was decided to use the likelihood-ratio test to calculate the statistic and to condense all military choices when calculating goodness of fit. The resulting likelihood-ratio test statistic is distributed chi square with three degrees of freedom.

For half of the years reported in Table A.8, the test does not reject the null hypothesis at a 5% significance level that the simulation's choice distribution is consistent with the data's choice distribution. Examining Table A.8, it is noteworthy that all three statistics reported after age 30 do not reject the null hypothesis. If every test statistic after age 30 was reported, about two thirds of all test statistics would not reject the null hypothesis.

Table A.9 contains the simulation's sector transition percentages. As in the data, there is a high degree of choice persistence in the simulation. The predicted transition rate from the civilian sector to the civilian sector is 93.1% compared to an actual rate of 91.0%. Transitions from the civilian sector to home are predicted at 5.5% compared to an actual 7.4%. Simulated schooling transitions fit the data, with a predicted school to school transition rate of 51% compared to an actual rate of 52%. Transitions from the home sector to the home sector are over-predicted by a few percentage points. The active duty to active duty transition rate is predicted to be 89% compared to an actual transition rate of 85%. About 4.5% of active duty participants are predicted to transition to the civilian sector. Except for the transition from the reserves to the civilian sector, reserve transitions are well predicted.

Table A.10 reports simulated military participation rates. Military participation rates are well predicted, with the predicted overall rate of 9.7% being slightly higher than the actual rate of 9.6%. Among whites, the predicted military participation rate is 9.36% compared to an actual rate of 9.24%. The predicted participation rate among blacks is 12.22% compared to an actual rate of 12.32%.

Table A.10 also contains average military career length information for men who join the military. Due to data attrition it is difficult to compare simulated average career length to the actual average career length. With data attrition, average career length is 5.4 years with whites staying 5.4 years and blacks staying 5.6 years. The simulation predicts that average career length is 6.1 years with whites staying 5.8 years and blacks staying 7.8 years. In both the data and the simulation, blacks on average stay in the military longer than whites.

Table A.11 reports wage fit. Both the civilian and active duty wage mean and standard deviation are well predicted. The reserve duty mean wage, however, is over-predicted. This result probability occurred because the reserve wage distribution is highly skewed and the number of reserve duty wage observations is low.

Table A.12 reports the simulated and actual AFQT quartile score distribution for military participants. The AFQT quartile score distribution below the median is well predicted. Additionally, the simulation is consistent with the military recruitment policy that no more than 25% of military participants may have an AFQT score below the third decile. Above the median, the simulation distribution slightly over-predicts the proportion of military participants with an AFQT score in the fourth quartile.

Parameters

All parameter estimates and standard errors are reported in the appendix. Table A.22 reports all civilian and military wage offer parameter estimates. The civilian sector wage offer's parameter estimates reveal that the civilian sector places a high premium on civilian sector experience relative to military sector experience. Specifically, for individuals with no experience in either sector, civilian wages increase 10.68% with an extra year of civilian experience and 2.76% with an extra year of military experience. Table A.22 also reports the parameter estimate for the racial term in the civilian setor wage offer, which is interpreted as either a racial difference in the civilian sector human capital rental rate or racial differences in civilian sector skill endowments. With a negative value, the parameter suggests the presence of racial discrimination in the civilian sector and/or racial differences in civilian sector skill endowments that are favorable to whites.

Table A.22 also reports the parameter estimates from the base pay regression. When entering the military, a new active duty recruit can expect to earn about $5,500 a year. Base pay increases in both pay grade and military experience. More specifically, being promoted adds about $1,150 to an active duty salary while acquiring a year of military experience increases active duty pay by just over $300. Again, with an R^2 value of 0.93, the base pay regression fits the base pay data well.

Table A.13 contains the business cycle transition matrix as well as the estimated civilian sector search cost for the severe business cycle state. The probability of transitioning from the good business cycle state to the severe business cycle state is about 35%, while the probability of the opposite transition is 40%. If the economy is in the severe business cycle state, individuals pay a $635 search cost to find a civilian sector job. Adjusted for inflation, the search cost in the severe business cycle state is about $1,350 in 2009 dollars.

Types

It is assumed that the sample comprises four heterogeneous types, with each type representing a set of sector skill and preference endowments at age 18. Table A.14 reports type probabilities by race, high school diploma status at age 18, and AFQT quartile score. The type probability distributions help to explain racial differences in the data. For both whites and blacks, type probabilities change as AFQT quartile score increases. Specifically, as AFQT quartile score increases, the probability of being type two decreases and the probability of being type four increases. This AFQT trend is especially significant for blacks because blacks' AFQT scores reside primarily in the first and second quartiles. Consequently, when compared to whites, relatively more blacks are type two - a type that possesses a very high home preference and low skill and preference endowments across all other sectors. Since whites' AFQT scores are almost uniformly distributed across quartiles, whites are relatively more likely to be type four - a type that has very high civilian sector skills and a high schooling preference.

Both whites and blacks are very likely to be type one or type three. When compared to the other two types, type one and type three individuals have high skill and preference endowments across all sectors, including active duty service. It may initially appear odd that between type one and type three relatively more whites than blacks are type one. After all, type one individuals have the highest active duty skills, but in the data, blacks choose active duty service at a relatively higher rate than whites. The decision to join the military, however, is not determined by active duty skill endowments alone. Rather, each man considers his skill and preference endowments across sectors when making the military participation decision. When compared to type three, type one men have higher skill and preference endowments across all sectors, which makes all sectors attractive. Consequently, it is understandable that type one whites who have the highest active duty skill endowments do not necessarily join the military at a greater rate than blacks.

Tables A.15 through A.18 report the choice distribution for each type. For the sake of brevity, this paragraph focuses on the type choice distribution at age 20. While a substantial percentage of all types work in the civilian sector, at just over

56%, type one has the largest proportion working in the civilian sector. By age 20, most men who attend school attend college. A very large proportion of type four men attend college, while a small percentage of type two men attend college. Type two men spend a lot of time at home relative to other types, while type four men are least likely to stay home. Most active duty participants are type three, although type one and type two men also serve active duty. While no type four men serve active duty, the majority of reservists are type four.

Chapter 6

Discussion and Experiments

This chapter discusses the estimation results and presents the counterfactual experiments. The parameter estimates provide insight into the factors that motivate military service. Unobserved heterogeneity accounted for by the finite type mixture reveals that skill and preference endowments vary widely across men. While men possess a wide range of active duty skill endowments, men with higher endowments of active duty skills are more likely to join the military. When making the military participation decision, however, men take into account their skills and preferences across all sectors. Consequently, possessing high active duty skills does not necessarily guarantee that a man will join the military. For example, type three men, who by far have the greatest active duty participation rate, do not possess the greatest active duty skills across types. Rather, type three men possess a high active duty skill endowment and relatively low skill and preference endowments in other sectors. Men whose endowments give them high active duty skills relative to their other skills are most likely to join the military.

While important, skill and preference heterogeneity is not the only factor that influences the military participation decision. The civilian sector search cost, which varies over the business cycle, is another influencing factor. If the business cycle state is severe, the civilian sector search cost is high and men are dissuaded from entering the civilian workforce. Since civilian sector wage offers are lowest when men are young and have little civilian sector human capital, the civilian sector search cost is most effective in dissuading civilian sector participation during the model's initial decision periods. The civilian sector search cost drives young men away from the civilian workforce and into other sectors. If a young man receives low utility from attending school or staying home and is dissuaded from the civilian workforce by the high search cost associated with a severe business cycle state, then he is likely to perceive the military as his most attractive option.

The estimated value of the racial term in the civilian wage offer aids in understanding why blacks join the military more than whites. Whether attributed to racial discrimination and/or racial differences in civilian skill endowments, the racial term's negative value means that all other things equal blacks receive lower average civilian sector wage offers than whites. This creates an incentive for blacks to join non-civilian sectors such as the military.

The model reveals that some factors surprisingly do not influence the military participation decision. Some research has supported the suggestion that men receive a large positive non-pecuniary reward from military service - a so called "patriotism effect."[1] The model's active duty reward function includes a parameter that captures the non-pecuniary utility associated with military service. Thus, it has been suggested that this non-pecuniary utility term - which includes the patriotism effect - should be positive. But after estimation the non-pecuniary utility associated with active duty service is revealed to be essentially zero. The result does not imply, however, that the patriotism effect is negative because the non-pecuniary utility term is the net utility of all non-pecuniary military service incentives and disincentives. Rather, the term's value suggests that disincentives to military service such as loss of personal freedom or time away from family are strong enough to counter military service incentives such as the patriotism effect.

The model also provides a mechanism for some results found in the literature. The parameter estimates reveal that the civilian sector places a substantial premium on civilian experience relative to military experience. Consequently, when a man retires from the military and enters the civilian workforce, he brings with him experience that is valued less than the experience he would have accumulated if he had been part of the civilian workforce in the past. Furthermore, the man's peers who acquired civilian experience while the man was in the military will receive a higher civilian sector wage than the man because they possess more valuable civilian sector human capital. Recall that Angrist (1998) and Hirsh & Mehay (2003) control

[1] Kleykamp (2006)

for selection into the military and find that on average military veterans earn less in the civilian sector than men who have never served in the military. The parameter estimates and the consequences the estimates imply for military veterans entering the civilian workforce are consistent with the results in Angrist (1998) and Hirsh & Mehay (2003).

The estimated model is used to conduct several counterfactual experiments. Most experiment results are reported in Tables A.19 and A.20.[2] The experiments can be divided into three categories: military compensation and promotion experiments, racial wage gap experiments, and business cycle experiments.

In the following sections many military participation rate, military career length, and race related results are reported. Noticeably absent from most reported results, however, is the military AFQT quartile score result. AFQT quartile score results are omitted because changes to the military AFQT quartile score distribution are highly correlated with the military's racial distribution. Blacks have AFQT quartile scores primarily in the first and second quartiles, while whites have an AFQT quartile score distribution that is more uniformly distributed across quartiles. Consequently, when blacks leave the military the average AFQT quartile score increases. Reporting the racial result sufficiently imparts the AFQT quartile score result.

[2]Tables A.19 and A.20 report the military participation rate and average military career length for all experiments as well as for the baseline simulation.

6.1 Compensation and Promotion Experiments

The model can be used to perform experiments that alter the military compensation structure in various ways. Experiments can alter the return to pay grade, the return to military experience, pension payments, etc. This study alters military base pay and military pension payments in order to determine military participation elasticities. The base pay elasticity experiments, which alter military base pay by varying degrees, reveal that the military participation rate increases about 5% for a 1% increase in base pay.

This experimental result is in a partial equilibrium context. In reality, as military wages increase the probability also increases that the civilian sector would respond by increasing civilian sector wages. If civilian sector wages increase with military wages, men would be less likely to join the military than if civilian sector wages did not change. Consequently, if military wages rise enough, then the military wage elasticity might be lower than the experimental result. At the margin, however, it is unlikely that the civilian sector would increase civilian sector wages in response to a slight increase in military wages. Thus, at the margin the experimental military wage elasticity result is likely the true military wage elasticity.

Previous studies have reported various military wage elasticity values. Although varying widely, most reported elasticities are less than the 5% elasticity reported in this study. Upon closer examination, however, it becomes clear that previous studies and this study are reporting different elasticities. Previous studies have calculated the military wage elasticity of retention. That is, previous studies have determined to what extent the rate at which servicemen leave the military changes as military wages change. This study calculates to what extent the military participation rate changes as military wages change. No previous study has reported the military wage elasticity of military participation.

When considering alterations to the military compensation structure, policymakers are rarely concerned just with how the change will affect the military participation rate. Fortunately, in addition to providing the military wage elasticity, the military base pay experiments reveal how average military career length and military AFQT distribution change as military wages change. In contrast to military participation, average military career length does not change much in response to increases in base pay. When base pay increases 2.5%, average military career length increases 3.9% to 6.36 years.

One question typically asked by military manpower experts is, how can the military draw in "smarter" recruits? The military base pay experiments suggest that increasing military wages improves recruit quality. More specifically, increasing base pay lowers the proportion of men in the military with an AFQT score in the lowest quartile. Since men in the lowest AFQT quartile are considered the least desirable military recruits, increasing base pay makes military recruits "smarter," in some sense.

Experiments are also performed to determine the elasticity of military participation with respect to military pension payments. The experiments increase pension payments by varying degrees and all find no change in the military participation rate, average military career length, military AFQT quartile distribution, etc. The future is too heavily discounted to make military pension payments a factor that influences the military participation decision. Additionally, the experiments' revelation that military pension payments have little influence helps to explain why military careers are so short. Men join the military not because it will eventually qualify them for a pension but because it is in their immediate interest.

In addition to altering the military compensation structure, the model can be used to perform experiments that alter the military promotion structure in various ways. To improve the military retention rate, in 2000 Congress approved a military pay increase targeted at experienced military personnel. But what if instead of increasing military pay the military had increased promotion rates instead? Would there have been significant gains in retention? To examine this possibility, two experiments are performed.

In the first experiment the promotion rates for E4 and above are doubled. Promotion at E4 and above is difficult - the probability is almost always under 10%. Doubling the promotion rates, therefore, results in promotion rates that are still low but not as low as before the experiment. The experiment increases average career length by 18% to 7.2 years. Additionally, the military participation rate does not change after the experiment. Thus, increasing promotion rates in 2000 would have achieved the same goal as the military pay increase.

In the second experiment, a more stringent promotion rate increase is introduced. To determine what would happen if the military wanted to only promote more educated personnel more quickly, the promotion rates for E4 and above are doubled only for servicemen with at least a year of college education. The experiment increases average career length by 3% to 6.3 years and, as in the first experiment, the military participation rate does not change.

6.2 Racial Wage Gap Experiments

Various studies, such as Laurence (1992) and Moskos & Butler (1996), have argued that blacks and other minorities are attracted to military service because unlike the civilian sector the military provides equal employment and promotion opportunities. This lack of equal civilian sector opportunities is possibly best embodied by the racial wage gap in the civilian sector. But what if the civilian sector racial wage gap decreased? How would black military participation respond?

Before discussing experiments that influence the civilian sector racial wage gap, it is important to briefly recall how racial differences enter the model. In the model, the civilian sector racial wage gap is due to [1] racial differences in skill endowments via the type distribution and [2] a racial term in the civilian wage offer that captures a racial discrimination effect and/or further racial differences in skill endowments. In addition to racial differences in the model, racial differences in the data also contribute to the civilian sector racial wage gap. More specifically, different racial education attainment distributions in the data indicate different racial civilian sector human capital distributions and consequently generate different racial civilian wage offers in the model.

As the previous paragraph outlines, the civilian sector racial wage gap is generated from multiple sources. There are, therefore, multiple experimental approaches to reducing the wage gap. This study performs three experiments that reduce the racial wage gap. Each experiment takes a different approach.

The first experiment removes the racial term from the civilian wage offer. Removing this term removes any and all racial discrimination from the civilian wage offer and may also remove some racial differences in civilian skill endowments. The experiment reduces the black military participation rate by 38%. Average black military career length drops by 7% in the experiment. Given the ambiguity associated with interpreting the civilian wage offer's racial term, the experiment's result is difficult to interpret. The result does, however, place an upper bound on the effect removing all civilian sector racial discrimination would have on military participation.

The second experiment does not change a feature of the model. Rather, the second experiment alters the data's black education attainment distribution at age 18 to match the education attainment distribution of whites at age 18. The proportion of blacks who are high school graduates at age 18 increases. The experiment reduces the black military participation rate by 32% and reduces average black military career length by 10%. Having more education at age 18 provides blacks with more civilian sector human capital, which reduces the racial wage gap and makes civilian sector employment more attractive. Consequently, blacks leave the military in large numbers and enter the civilian sector.

The effect sizes of the two experiments above are so large that they both result in a black military participation rate that is below the military participation rate of whites. It has to be, therefore, that removing racial differences in the civilian sector skill endowment via the type distribution increases black military participation. Experiment three performs this action. When racial differences in the type distribution are removed, black military participation does increase substantially.

Interpreting experiment three's result is difficult for two reasons. First, the presence of the racial term in the civilian sector wage offer again makes interpreting the effect on civilian sector skills difficult. Second, the type distribution affects skills and preferences in all sectors. Consequently, more blacks could be entering the military not because of civilian sector skill gains but because of skill and preference changes outside the civilian sector.

Finally, another interesting question related to the civilian sector racial wage gap is to what extent black wages would decrease if the military did not exist as an employment option. To answer this question it would be necessary to remove all military options available to individuals. Fortunately, the model can be altered in this way. Removing military options from the model decreases black wages by 0.33% and decreases black welfare by 0.32%. Blacks would be worse off if the military did not exist, but not substantially worse off.

6.3 Business Cycle Experiments

Although the military reports that its recruitment success is negatively correlated with the business cycle, little research has attempted to quantify the effect that the business cycle has on military recruitment. This section presents three experiments that attempt to reveal to what extent the business cycle affects military recruitment.

Before presenting the business cycle experiments, it is important to recall how the business cycle enters the model and to discuss how the business cycle can be experimentally altered. The business cycle enters the model in the form of a civilian sector search cost. During decision periods in which the severe business cycle state is realized, men entering or re-entering the civilian sector must pay a job search cost. The business cycle state evolves probabilistically between decision periods.

In the model, the business cycle can be altered in two ways. The search cost that a man pays for entering or re-entering the civilian sector can increase or decrease in either business cycle state. Additionally, transition probabilities between business cycle states can be altered.

Three business cycle experiments are preformed. In the first business cycle experiment, the probability of staying in the severe business cycle state is altered. Specifically, the transition probability from the severe business cycle state to the good business cycle state is changed from about 40% to 70%. In other words, the experiment makes the severe business cycle state less persistent. The military participation rate decreases by 3.2% in the experiment, while average military career length decreases 1.8%. Overall, making the severe business cycle state less persistent has relatively little effect on military participation.

In the second and third experiments, the search costs are altered. The second experiment attempts to understand what would happen if no business cycle variation existed. To accomplish this goal, the experiment removes the state varying search costs from the model and replaces them with a non-varying average search cost. Removing search cost variation decreases the military participation rate 5.6% and decreases average military career length by 0.8%. This result suggests that military recruitment is more sensitive to economic contraction than to economic expansion.

The third experiment attempts to ascertain the effect one severe business cycle state has on military recruitment. Similar to an impulse response experiment in the macroeconomic literature, the third experiment makes all men encounter the severe business cycle state search cost at age 18. After age 18, however, all men encounter the non-varying average search cost. When compared to the results from the second experiment, the third experiment increases the military participation rate by 13.3% and increases average career length by 2.5%. For blacks the effect is even greater with a 14.1% increase in the military participation rate.

Notice the effect size difference between the experiments that alter search costs and the experiment that alters business cycle transition probabilities. The severe business cycle state persistence is altered substantially in the transition probability experiment - it is reduced by 50% - and yet the resulting effect size is relatively small. Recall that men discount the future when making their decisions and that business cycle transition probabilities concern only the future. Consequently, the transition probability experiment only alters discounted future utility. The search cost experiments, however, alter current utility as well as discounted future utility. Furthermore, the impulse response experiment, which has by far the largest effect size, only alters the search cost at age 18. Similar to the military compensation experiments, the results from the business cycle state experiments suggest that the decision to join the military is not made based on future considerations (i.e., discounted future utilities) as much as it is made by immediate concerns (i.e., the current decision period's reward function values).

There is one noticeable limitation to the experiments above. It is reasonable to think that, like individuals, the military alters its behavior in response to the business cycle. For example, during the severe business cycle state the military may impose more stringent education attainment standards for enlistment or lower its signing bonuses. Unfortunately, the unavailability of military behavior data makes modeling the military's actions very difficult. Consequently, the business cycle experiments take the military's actions as given.

Chapter 7

Conclusion

To examine the role that compensation, race, and the business cycle play in military recruitment, this study develops and empirically implements a model of lifetime career decision making that includes military service options. Men in the model receive civilian and military wage offers each year and then choose whether to join the civilian workforce, attend school, stay home, serve active duty military, or serve reserve duty military. Forward looking, each man makes choices understanding how they affect his expected future utility. The military compensation and promotion structure are modeled in detail. Business cycle effects are included in the model through the introduction of a business cycle varying job search cost that men who enter or re-enter the civilian workforce must pay. To study the effect race has on military participation, skill and preference endowments as well as civilian wage offers are allowed to vary by race. The model is estimated using simulated maximum likelihood and data on males from the NLSY79.

The estimation results provide new insight into why men join the military. Heterogeneity in skills and preference endowments across sectors influences the military participation decision. As the business cycle state worsens, the civilian sector search cost rises, which drives men away from the civilian workforce and into other sectors such as the military. Relative to whites, blacks receive lower civilian sector wage offers, which encourages blacks to accept military wage offers at a greater rate than whites. The civilian sector places a high premium on civilian experience relative to military experience, which could explain why military veterans on average earn less in the civilian sector than men who do not join the military.

The counterfactual experiments contain several interesting results. Experiments that increase military pay discover that for every 1% increase in military pay, military participation rises about 5%. Additionally, increasing military compensation improves the quality of military recruits. Increasing military promotion rates significantly increases average military career length without changing the military participation rate. Skill heterogeneity plays a substantial role in explaining racial differences in civilian wage offers. Removing business cycle variation from the model decreases the military participation rate by about 6%, while decreasing the persistence of the severe business cycle state has a much smaller effect. Both business cycle experiments have little effect on average military career length. Introducing the severe business cycle state at age 18 followed by no business cycle variation increases the military participation rate by 13%. Military participation is not very sensitive to changes in future compensation, such as increasing military pension payments.

Future model extensions will require more data. Specifically, if military behavior data could be obtained, the model could be extended to allow the military to adjust its recruitment standards and compensation structure over the business cycle. Additionally, if more military personnel data could be obtained and some concessions are made regarding state space size, joining the military as a commissioned officer could be introduced into the choice set.

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Appendix A

A.1 Exact Functional Forms

It is important to allow the model to distinguish age and persistence trends from unobserved heterogeneity. Otherwise, the estimated model might overstate the degree of unobserved heterogeneity. This section presents the model's exact functional forms. Wage offers, pension payments, and reward functions are fully described, including all age and persistence parameters. Except for the schooling and home reward functions, the wage offers, pension payments, and reward functions described below are very similar to the basic forms described previously.

A.1.1 Wages

At the beginning of each decision period each man receives wage offers from the civilian sector, the active duty military, and the reserve duty military. The civilian, active duty, and reserve duty wage offers take the following functional forms:

$$w_a^c = r^c \exp\{\beta_{0,c} + \beta_{b,c}\mathbb{1}_{blk=1} + \beta_{1,c}g_a + \beta_{2,c}\chi_a^c + \beta_{3,c}\chi_a^m + \beta_{4,}\chi_a^{c\,2} + \beta_{5,c}\chi_a^c\chi_a^m + \varepsilon_a^c\}$$

$$w_a^{at} = base(pg_a, \chi_a^m) \cdot r^a t \exp\{\beta_{0,at} + \beta_{1,at}pg_a + \beta_{2,at}\chi_a^m + \varepsilon_a^{at}\}$$

$$w_a^r = base(pg_a, \chi_a^m) \cdot r^r \exp\{\beta_{0,r} + \beta_{1,r}pg_a + \beta_{2,r}\chi_a^m + \varepsilon_a^r\}$$

Military wage offers are a function of military base pay. Base pay is a linear function of pay grade and military experience:

$$base(pg_a, \chi_a^m) = \beta_{0,b} + \beta_{1,b}pg_a + \beta_{2,b}\chi_a^m$$

A.1.2 Pension Payments

A man receives military pension payments only if he has served in the military for at least 20 years and is no longer in the military. If a man has served at least 20 years active duty, he starts receiving pension payments as soon as he leaves the military. If a man has served at least 20 years reserve duty, he starts receiving pension payments at age 60. Combining the military pension formula and the pension start date rules, military pension payments take the following form:

$$pension = \mathbb{1}_p \left(base(pg_a, \chi_a^m) \cdot \left(\frac{points}{365} \right) \cdot 0.025 \right)$$

$$\text{where } p = \begin{cases} \chi_a^{at} \geq 20, d_a^{at} = 0 \\ \text{or} \\ \chi_a^r \geq 20, d_a^r = 0, a \geq 60 \end{cases}$$

A.1.3 Military Exit Parameter

Most servicemen leave the military after four to six years of military service. The model's basic structure, however, is unable to fully capture this behavior. Consequently, a non-pecuniary utility parameter was added to the non-military reward functions of men who are currently in the military and have four or more years of military experience. The utility parameter, which varies according to a serviceman's military experience, incentivizes servicemen with four or more years of military experience to leave the military. The military exit parameter takes the following form:

$$\beta_m = d^m_{a-1}(\beta_{4,m}\mathbb{1}_{\chi^m_a=4} + \beta_{5,m}\mathbb{1}_{\chi^m_a=5} + \beta_{6,m}\mathbb{1}_{6\leq\chi^m_a})$$

A.1.4 Reward Functions

The model has six reward functions. The civilian sector reward function takes the following form:

$$\begin{aligned} R^c(S_a) = w^c_a &+ \beta_{6,c}\mathbb{1}_{12\leq g_a} + \beta_{7,c}\mathbb{1}_{16\leq g_a} \\ &+ \beta_{8,c}d^c_{a-1} + (1-d^c_{a-1})\sum_j \beta_j \mathbb{1}_{j_a} + \beta_m + pension \end{aligned}$$

where $\beta_{6,c}$ and $\beta_{7,c}$ are parameters that capture the non-pecuniary utilities associated with possessing a high school diploma or college degree, respectively.

Since choices persist in the data, adding persistence parameters to the reward functions aids in model fit. Persistence parameters were added to all reward functions except the schooling reward function. For the civilian reward function, $\beta_{8,c}$ is the persistence parameter.

Several parameters were added to the schooling reward function. The schooling re-entry parameter was separated into two parameters ($\beta_{9,s}$ and $\beta_{10,s}$), which allows the re-entry cost to vary by the type of schooling the man is re-entering. To capture racial differences in school attendance that are present in the data, a racial parameter $\beta_{4,s}$ was added. School attendance behavior at age 18 and 19 is very different than school attendance behavior at age 20 and beyond. This difference arises because at ages 18 and 19 many men are transitioning between high school, college, and other sectors. To address school attendance behavior trends, four parameters ($\beta_{5,s}$,$\beta_{6,s}$,$\beta_{7,s}$,$\beta_{8,s}$,) were added to the schooling reward function. With these additions, the schooling reward function is given by:

$$\begin{aligned} R^s(S_a) = \beta_{0,s} &+ \beta_{1,s}\mathbb{1}_{12\leq g_a<16} + \beta_{2,s}\mathbb{1}_{16\leq g_a} + \beta_{3,s}\mathbb{1}_{a=20}\mathbb{1}_{12\leq g_a} + \beta_{4,s}\mathbb{1}_{blk=1} \\ &+ \mathbb{1}_{12\leq g_a}\cdot(\beta_{5,s}\mathbb{1}_{a=18} + \beta_{6,s}\mathbb{1}_{a>20}(a-20)) + \mathbb{1}_{g_a<12}\cdot(\beta_{7,s}\mathbb{1}_{a=18} + \beta_{8,s}\mathbb{1}_{a=19}) \\ &+ \mathbb{1}_{18<a}\cdot(1-d^s_{a-1})\cdot(\beta_{9,s}\mathbb{1}_{g_a=12} + \beta_{10,s}\mathbb{1}_{13\leq g_a\leq 15}) + \beta_m + \varepsilon^s_a \end{aligned}$$

Several parameters were also added to the home reward function. Parameters $\beta_{1,h}$ and $\beta_{2,h}$ capture non-pecuniary utilities associated with possessing a high school diploma or college degree. To capture racial differences in home sector participation that are present in the data, a racial parameter $\beta_{9,h}$ was added. A school to home transition parameter $\beta_{4,h}$ helps the model to draw men transitioning from school into the home sector. To fit the declining home participation trend, which does not decrease linearly, four parameters ($\beta_{5,h}$,$\beta_{6,h}$,$\beta_{7,h}$,$\beta_{8,h}$,) were introduced to the home reward function. With these additions, the home reward function takes the following form:

$$
\begin{aligned}
R^h(S_a) = \beta_{0,h} &+ \beta_{1,h}\mathbb{1}_{12\leq g_a} + \beta_{2,h}\mathbb{1}_{16\leq g_a} \\
&+ \beta_{3,h}d^h_{a-1} + \beta_{4,h}\mathbb{1}_{18<a}d^s_{a-1} + \beta_{5,h}\mathbb{1}_{a=18} + \beta_{6,h}\mathbb{1}_{19\leq a\leq 20} \\
&+ \beta_{7,h}\mathbb{1}_{21\leq a\leq 22} + \beta_{8,h}\mathbb{1}_{23\leq a\leq 24} + \beta_{9,h}\mathbb{1}_{blk=1} + \beta_m + pension + \varepsilon^h_a
\end{aligned}
$$

Except for persistence terms and an age 18 parameter for staying home and serving in the reserves, the military reward functions are unchanged:

$$R^{at}(S_a) = \beta_{at} + w^{at}_a + \beta_{3,at}d^{at}_{a-1}$$

$$R^{cr}(S_a) = R^c_a + \beta_{cr} + w^r_a + \beta_{3,cr}d^{cr}_{a-1}$$

$$R^{hr}(S_a) = R^h_a + \beta_{hr} + w^r_a + \beta_{3,hr}\mathbb{1}_{a=18} + \beta_{4,hr}d^{hr}_{a-1}$$

A.2 Data

When gathering data, it became apparent that most variables could not be taken directly from the NLSY79 and therefore needed construction. There are several reasons this occurred. First, the NLSY79 data are collected over varying time horizons. For example, wages are reported by calendar year while military participation is reported by interview period. Consequently, the NLSY79 data do not often align with the model's decision period. Second, NLSY79 does not always contain data that maps directly to variables of interest for the model. For example, the NLSY79 does not contain a variable that map directly to the model's choice set. Finally, state space considerations sometimes required condensing the NLSY79 variables. This section describes how variables were constructed.

A.2.1 The Choice Variable

The following hierarchical order was used to construct the choice variable. The evolution of civilian experience, military experience, and education attainment follows from the choice variable.

Military Service

NLSY79 respondents are asked each interview whether they have joined the military since their last interview. If a respondent indicates that he joined the military since his last interview, information is then gathered regarding the month joined, year joined, and service branch. This information reveals in what decision period the respondent joined the military and what duty type he served.

If a respondent's enlistment month or enlistment year was not reported, it is unclear in which decision period the man joined the military. Therefore, if enlistment month or enlistment year was not reported, then it was assumed that enlistment occurred sometime between the interview date and the previous July 1.

A respondent's ability to participate in other sectors while in the military depends on his duty type. If the respondent served active duty, then he cannot participate in any other sector. However, if the respondent served reserve duty, he must also participate in either the civilian or home sector.

School Attendance

The NLSY79 contains a variable that indicates a respondent's grade level as of May 1 each year. If a respondent's grade level rose according to the proceeding value of this variable and he did not serve active duty military, then the respondent was recorded as having attended school.

Civilian Sector Participation

NLSY79 respondents are asked for their weekly civilian work hours. If a respondent did not serve active duty, did not attend school, and worked in the civilian sector an average of at least 20 hours during the decision period, then the respondent was said to have participated in the civilian sector.

To determine whether a respondent worked in the civilian sector an average of at least 20 hours during the decision period, reported hours worked was averaged for certain weeks during the first and second quarters of the current calendar year and the fourth quarter of the previous calendar year. The third quarter of the previous calendar year was omitted from the averaging in an effort to exclude students' summer employment from the choice construction process. The first, seventh, and thirteenth weeks of a quarter were used to gather the quarter's work information.

This is as in Keane & Wolpin (1997).

Home Sector Participation

If a respondent did not serve active duty, did not attend school, and did not participate in the civilian sector, then the respondent was said to have stayed home.

A.2.2 Other Variables

The variables for age and race were taken directly from the NLSY79. All other variables were to some extent constructed from the NLSY79 data. The following paragraphs describe how the other variables were constructed. For the variables described below that are censored, the censoring occurred after the choice variable was constructed.

Pay Grade

There were three challenges when constructing the military pay grade variable. The first challenge involved the inclusion of officers. Only 31 men in the sample become commissioned officers and five men in the sample become warrant officers. Furthermore, including commissioned and warrant officer pay grades in the model would expand the state space to a computationally unmanageable size. Given the lack of officers in the data and the computational complexity associated with including officer pay grades in the model, it was decided to exclude commissioned and warrant officers from the analysis sample.

The second pay grade construction challenge involved the lowest enlisted pay grade E1. Most servicemen hold a pay grade of E1 during the first four months of service (i.e., during basic training) and are then promoted. At the end of the first decision period most servicemen hold the pay grade of E2. Promotion at all other pay grades, however, usually takes at least a year. To make pay grade promotion take at least a year at all pay grades, E1 and E2 were combined into one pay grade in the state space.

The third pay grade construction challenge involved the highest enlisted pay grades E8 and E9. Due to both data and promotion attrition, only 16 servicemen in the data reach the pay grade of E8 or E9. Given how few men attain E8 or E9, it was decided to lessen the model's computational burden by collapsing pay grades E8 and E9 into E7 in the state space.

Civilian Experience

Civilian wages are an increasing but concave function of civilian experience. Consequently, men with high levels of civilian experience do not see large increases in their civilian wages as they accumulate more civilian experience. Taking advantage of this fact, the state space does not allow individuals to possess more than 20 years of civilian experience. Men with 20 years of civilian experience can work in the civilian sector in the model but cannot accumulate additional civilian experience. This configuration decreases the state space by 32%.

Military Experience

When constructing the active duty and reserve duty experience variables, it was revealed that 35 men in the data serve both active duty and reserve duty. To accommodate these 35 people, it would have been necessary for the state space at any level of military experience to include all possible combinations of active duty and reserve duty experience that sum up to that level of military experience. For example, a man with two years of military experience could have two years of active duty experience, a year of active duty experience and a year of reserve duty experience, or two years of reserve duty experience. Allowing for all possible military experience combinations expands the state space by over 800%. Additionally, men who served both military duty types often reported spending only one year in one of the duty types. For these reasons it was decided to drop the 35 men who serve both active duty and reserve duty from the analysis sample.

Education Attainment

When constructing the education attainment variable, it was decided to ease the model's computational burden by collapsing some of the education attainment state space. As a function of education attainment, civilian wages for high school dropouts who have not completed the eleventh grade are low and not widely distributed. Therefore, all grade levels below the eleventh grade (high school sophomores and below) were collapsed into one grade level. Additionally, since relatively few men attend graduate school, grade levels seventeen and up (graduate school) were collapsed into one grade level. Men with a year of graduate education can attend school in the model but cannot accumulate more education. Grade levels eleven (high school junior) through sixteen (college senior) were unchanged.

AFQT Quartile Score

AFQT scores are reported on a 1 to 100 scale in the data. The score value represents an individual's AFQT percentile ranking. The AFQT quartile score variable was constructed by sorting AFQT scores and then assigning each score to a quartile.

Due to state space concerns, it was decided to not include AFQT quartile score in the state space directly. Rather, a new variable was constructed using schooling attainment, which is in the state space, and AFQT quartile score to indicate whether a man is possibly ineligible for military service. The presence of the military ineligibility variable in the state space allows each man to properly weight the discounted expectation of the next decision period's value function.

In addition to the military ineligibility variable, AFQT quartile score indirectly enters the state space through the endowment type distibution. The probability of being a certain type is conditioned on AFQT quartile score. Endowments, therefore, are a function of AFQT quartile score.

Wages

Civilian and military wages also needed construction. During each NLSY79 interview, respondents were asked to report their civilian and military wages during the past calendar year. It was from these wage reports that decision period wages were constructed. To align the reported wages with the decision period, wages from the two calendar years included in the decision year were each weighted by half and then summed. Reported wages were also transformed into real values during wage construction with 1982-1984 as the base year.

		White		Black		All Races	
	Variable	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
All	Obs. Number	11.93	7.77	11.80	7.84	11.92	7.78
Observations	Age	22.87	7.10	22.59	7.56	22.83	7.16
	Year	1989.96	8.05	1989.42	8.12	1989.89	8.06
	Active Exp.	0.50	1.72	1.28	3.12	0.60	1.98
	Reserve Exp.	0.11	0.98	0.15	1.22	0.12	1.01
	Civilian Exp.	7.07	6.62	5.53	6.14	6.86	6.58
	Grade Level	12.83	2.28	12.13	1.79	12.74	2.23
	AFQT Score	54.20	28.36	24.09	21.59	50.22	29.38
	% Military	26.20	-	39.20	-	28.00	-
Military	Active Exp.	2.97	3.62	4.45	5.05	3.31	4.04
Observations	Reserve Exp.	5.08	5.35	6.23	6.39	5.30	5.57
	Pay Grade	2.63	1.24	3.04	1.49	2.73	1.31

Table A.1: Descriptive Statistics

Age		Civilian	School	Home	Active	Reserves	Total
18		739	1,123	938	65	31	2,896
		25.52%	38.78%	32.39%	2.24%	1.07%	100.0%
19		1,047	911	725	122	44	2,849
		36.75%	31.98%	25.45%	4.28%	1.55%	100.0%
20		1,231	761	641	132	44	2,809
		43.82%	27.09%	22.82%	4.70%	1.56%	100.0%
21		1,376	620	583	132	44	2,755
		49.95%	22.50%	21.16%	4.79%	1.60%	100.0%
22		1,535	401	593	113	43	2,685
		57.17%	14.93%	22.09%	4.21%	1.61%	100.0%
23		1,689	250	533	93	38	2,603
		64.89%	9.60%	20.48%	3.57%	1.46%	100.0%
24		1,823	158	442	77	34	2,534
		71.94%	6.24%	17.44%	3.04%	1.34%	100.0%
25		1,836	136	401	61	28	2,462
		74.57%	5.52%	16.29%	2.48%	1.13%	100.0%
26		1,865	109	359	51	21	2,405
		77.55%	4.53%	14.93%	2.12%	0.87%	100.0%
27		1,853	92	332	38	17	2,332
		79.46%	3.95%	14.24%	1.63%	0.73%	100.0%
28		1,847	67	327	29	17	2,287
		80.76%	2.93%	14.30%	1.27%	0.74%	100.0%
29		1,828	45	319	23	15	2,230
		81.97%	2.02%	14.30%	1.03%	0.67%	100.0%
30		1,816	31	303	21	13	2,184
		83.15%	1.42%	13.87%	0.96%	0.59%	100.0%
35		1,716	2	228	14	8	1,968
		87.20%	0.10%	11.59%	0.71%	0.41%	100.0%
40		1,509	0	235	8	4	1,756
		85.93%	0.00%	13.38%	0.46%	0.23%	100.0%
45		470	0	82	1	1	554
		84.84%	0.00%	14.80%	0.18%	0.18%	100.0%

Table A.2: Choice Distribution by Age

Previous	Civilian	School	Home	Active	Reserves
Civilian	(91.01%)	(1.48%)	(7.36%)	(1.05%)	(0.04%)
School	(29.53%)	(51.50%)	(17.36%)	(1.22%)	(0.38%)
Home	(39.67%)	(5.83%)	(53.86%)	(0.54%)	(0.11%)
A. Duty	(4.56%)	(1.24%)	(9.32%)	(84.89%)	(0.00%)
Reserves	(8.84%)	(0.86%)	(3.66%)	(0.00%)	(86.64%)

Table A.3: Choice Transitions

Age	White	Black	All Races
18	1,429	145	1,574
	55.93%	42.52%	54.35%
19	1,971	206	2,177
	78.43%	61.31%	76.41%
20+	40,153	4,475	44,628
	86.27%	74.6%	84.94%

Table A.4: High School Diploma Status by Race

Age	No Diploma	Diploma	Total
18	41	55	96
	42.71%	57.29%	100.0%
19	11	74	85
	12.94%	87.06%	100.0%
20+	11	94	105
	10.48%	89.52%	100.0%

Table A.5: High School Diploma Status at Time of Enlistment

Age	Sample			Over Sample	
	Civilian	Active Military	Reserve Military	Civilian	Active Military
18	7,153.11	6,156.75	2,233.64	-	6,117.26
19	8,832.92	7,184.61	3,040.87	-	7,422.49
20	10,280.76	8,399.40	3,653.49	8,331.65	8,406.22
21	11,322.16	9,131.34	5,373.45	8,509.36	9,011.74
22	12,560.37	10,050.14	5,749.10	9,879.81	9,802.84
23	14,054.18	11,243.08	4,470.95	11,498.77	11,039.10
24	15,366.36	12,300.39	5,539.79	12,586.34	12,194.55
27	19,403.44	14,108.73	7,195.46	17,536.24	14,786.11
30	22,150.33	17,097.70	7,753.90	20,330.71	17,363.51
35	25,574.28	20,223.08	11,740.38	20,379.26	21,366.18
45	27,646.46	-	-	25,222.95	-

Notes: Ages with less than ten observations not reported. In 1982-1984 dollars.

Table A.6: Mean Wage by Age

Age	Civilian	School	Home	Active	Reserves
18	25.48%	42.59%	28.85%	2.10%	0.98 %
	(25.52%)	(38.78%)	(32.39%)	(2.24%)	(1.07%)
19	39.91%	30.11%	25.29%	3.64%	1.05%
	(36.75%)	(31.98%)	(25.45%)	(4.28%)	(1.55%)
20	48.50%	24.00%	22.22%	4.21%	1.07%
	(43.82%)	(27.09%)	(22.82%)	(4.70%)	(1.56%)
21	51.79%	21.83%	21.07%	4.18%	1.13%
	(49.95%)	(22.50%)	(21.16%)	(4.79%)	(1.60%)
22	59.53%	15.89%	19.35%	4.09%	1.14%
	(57.17%)	(14.93%)	(22.09%)	(4.21%)	(1.61%)
23	65.20%	10.26%	19.58%	3.62%	1.34%
	(64.89%)	(9.60%)	(20.48%)	(3.57%)	(1.46%)
24	70.51%	5.71%	18.92%	3.30%	1.56%
	(71.94%)	(6.24%)	(17.44%)	(3.04%)	(1.34%)
25	72.75%	4.90%	18.36%	2.78%	1.21%
	(74.57%)	(5.52%)	(16.29%)	(2.48%)	(1.14%)
26	74.80%	3.92%	17.93%	2.45%	0.91 %
	(77.55%)	(4.53%)	(14.93%)	(2.12%)	(0.87%)
27	77.89%	3.17%	16.06%	2.21%	0.67%
	(79.46%)	(3.95%)	(14.24%)	(1.63%)	(0.73%)
28	79.63%	3.00%	14.93%	2.00%	0.43%
	(80.76%)	(2.93%)	(14.30%)	(1.27%)	(0.74%)
29	81.02%	2.52%	14.46%	1.76%	0.23%
	(81.97%)	(2.02%)	(14.30%)	(1.03%)	(0.67%)
30	84.90%	0.00%	13.36%	1.62%	0.12%
	(83.15%)	(1.42%)	(13.87%)	(0.96%)	(0.59%)
35	87.18%	0.00%	11.74%	1.07%	0.01%
	(87.20%)	(0.10%)	(11.59%)	(0.71%)	(0.41%)
40	87.95%	0.00%	11.25%	0.80%	0.00%
	(85.93%)	(0.00%)	(13.38%)	(0.46%)	(0.23%)
45	87.57%	0.00%	11.83%	0.60%	0.00%
	(84.84%)	(0.00%)	(14.80%)	(0.18%)	(0.18%)

Note: Actual percentages in parentheses.

Table A.7: Simulated Choice Distribution by Age

Age	Civilian	School	Home	Military	Statistic
18	1.16	-105.25	108.57	6.90	22.76***
19	-86.37	54.90	4.57	36.14	18.49***
20	138.24	-81.65	-16.63	-25.25	29.43***
21	51.61	-18.18	-2.47	-27.08	7.75*
22	64.66	26.59	-68.81	-15.01	14.86***
23	8.09	17.76	-22.90	-1.81	2.26
24	-35.87	-12.84	39.05	12.81	6.28*
25	-44.26	-14.37	54.07	9.83	10.55**
26	-64.95	-13.64	78.96	9.43	19.60***
27	-36.25	-16.26	45.05	14.23	13.54 ***
28	-25.66	1.62	14.72	10.55	2.45
29	-21.06	12.43	3.59	6.99	3.89
30	38.62	-0.08	-10.93	4.39	64.00***
35	-0.39	-0.05	2.97	-0.77	3.50
40	35.88	0.00	-34.25	2.08	7.42*
45	15.36	0.00	-14.68	1.70	4.77

* significant at 10%, ** significant at 5%, *** significant at 1%

Table A.8: Choice Distribution Goodness of Fit: Likelihood Ratio Test Statistic

Previous	Civil.	School	Home	Active	Reserves
Civilian	93.15%	1.28%	5.51%	0.02%	0.05%
	(91.01%)	(1.48%)	(7.36%)	(1.05%)	(0.04%)
School	35.55%	51.29%	11.88%	0.94%	0.34%
	(29.53%)	(51.50%)	(17.36%)	(1.22%)	(0.38%)
Home	35.06%	1.84%	62.44%	0.43%	0.22%
	(39.67%)	(5.83%)	(53.86%)	(0.54%)	(0.11%)
A. Duty	4.31%	1.63%	5.42%	88.64%	0.00%
	(4.56%)	(1.24%)	(9.32%)	(84.89%)	(0.00%)
Reserves	18.33%	1.53%	1.05%	0.00%	79.08%
	(8.84%)	(0.86%)	(3.66%)	(0.00%)	(86.64%)

Note: Actual percentages in parentheses.

Table A.9: Simulated Choice Transitions

	Race	Data	Simulation
Participation	Whites	9.24%	9.36%
Rate	Blacks	12.32%	12.22%
	All	9.6%	9.70%
Career	Whites	5.36	5.84
Length	Blacks	5.60	7.75
	All	5.36	6.12

Note: Career length in years.

Table A.10: Military Participation & Career Length

		Data		Simulation	
Wage	Observations	Mean	St. Dev.	Mean	St. Dev.
Civilian	28,853	19,842.94	12,847.77	20,400.22	10,423.03
Active Duty	2,939	10,702.83	4,519.75	10,913.88	4,565.76
Reserve Duty	371	5,760.44	6,510.40	8,522.87	5,911.11

Note: In 1982-1984 dollars.

Table A.11: Actual and Predicted Wages

	Data	Simulation
Quartile 1	13.11%	11.76%
Quartile 2	27.34%	27.55%
Quartile 3	37.45%	29.88%
Quartile 4	22.10%	30.81%

Table A.12: AFQT Quartile Score Distribution for Military Participants

	Good State	Severe State
Search Cost	0	-635.20
Good State	65.5%	34.5%
Severe State	40.3%	59.7%

Note: Search Cost in 1982-1984 dollars.

Table A.13: Business Cycle States

	White				Black			
AFQT/Diploma	T1	T2	T3	T4	T1	T2	T3	T4
Q1/No Diploma	0.45	0.24	0.29	0.02	0.32	0.40	0.26	0.02
Q2/No Diploma	0.41	0.15	0.32	0.12	0.31	0.27	0.31	0.12
Q3/No Diploma	0.46	0.05	0.30	0.18	0.38	0.11	0.32	0.19
Q4/No Diploma	0.36	0.06	0.28	0.30	0.28	0.12	0.28	0.31
Q1/Diploma	0.56	0.15	0.27	0.02	0.44	0.27	0.27	0.02
Q2/Diploma	0.49	0.09	0.29	0.14	0.39	0.16	0.30	0.15
Q3/Diploma	0.51	0.03	0.26	0.20	0.44	0.06	0.28	0.22
Q4/Diploma	0.40	0.03	0.24	0.33	0.33	0.07	0.25	0.36

Table A.14: Estimated Type Probabilities

Age	Civilian	School	Home	Active	Reserves	Total
18	29.31	42.31	26.57	1.26	0.56	100
19	46.56	28.88	22.09	1.92	0.55	100
20	56.34	22.38	18.67	2.11	0.50	100
21	60.63	19.94	16.93	1.97	0.51	100
22	69.10	14.22	14.45	1.85	0.38	100
23	74.88	8.67	14.47	1.57	0.40	100
24	79.94	4.68	13.45	1.39	0.54	100
27	86.17	2.79	9.93	0.88	0.22	100
30	92.01	0.00	7.32	0.66	0.00	100
35	93.83	0.00	5.77	0.40	0.00	100
45	93.95	0.00	5.86	0.18	0.00	100

Table A.15: Type One Choice Distribution by Age

Age	Civilian	School	Home	Active	Reserves	Total
18	20.21	25.37	52.92	0.22	1.27	100
19	29.29	12.15	56.70	0.41	1.73	100
20	35.27	6.40	56.56	0.29	1.47	100
21	35.49	4.44	58.39	0.19	1.48	100
22	35.97	3.46	59.05	0.16	1.58	100
23	35.31	2.40	61.13	0.05	1.11	100
24	35.77	1.04	62.24	0.02	0.92	100
27	37.33	0.97	61.49	0.00	0.21	100
30	40.44	0.00	59.53	0.00	0.03	100
35	43.88	0.00	56.11	0.00	0.01	100
45	42.94	0.00	57.06	0.00	0.00	100

Table A.16: Type Two Choice Distribution by Age

Age	Civilian	School	Home	Active	Reserves	Total
18	25.87	39.61	28.70	5.64	0.18	100
19	40.16	25.93	23.47	10.19	0.25	100
20	49.00	19.17	19.53	12.03	0.27	100
21	52.20	16.80	18.52	12.19	0.30	100
22	58.80	12.11	16.74	12.05	0.30	100
23	63.58	7.98	17.33	10.82	0.29	100
24	68.49	4.36	16.89	9.93	0.32	100
27	75.11	3.51	14.58	6.74	0.06	100
30	83.36	0.00	11.73	4.91	0.00	100
35	86.35	0.00	10.36	3.29	0.00	100
45	88.24	0.00	9.86	1.90	0.00	100

Table A.17: Type Three Choice Distribution by Age

Age	Civilian	School	Home	Active	Reserves	Total
18	19.06	57.58	20.41	0.00	2.94	100
19	30.21	49.53	17.10	0.00	3.15	100
20	37.17	45.07	14.45	0.00	3.31	100
21	40.03	43.66	12.74	0.00	3.57	100
22	51.98	32.52	11.48	0.00	4.02	100
23	62.36	21.83	10.62	0.00	5.18	100
24	71.66	12.78	9.42	0.00	6.14	100
27	86.20	4.82	6.05	0.00	5.56	100
30	96.41	0.00	2.93	0.00	0.65	100
35	98.08	0.00	1.88	0.00	0.05	100
45	97.71	0.00	2.29	0.00	0.00	100

Table A.18: Type Four Choice Distribution by Age

		Baseline	1.0% Pay Increase	2.5% Pay Increase	Faster Promotion	Faster Promotion College
White	Part. Rate	9.36%	9.87%	10.59%	9.36%	9.36%
	% of Military	85.16%	85.12%	85.31%	85.16%	85.16%
	Career Length	5.84	5.90	6.10	6.94	6.01
Black	Part. Rate	12.22%	12.93%	13.67%	12.22%	12.22%
	% of Military	14.84%	14.88%	14.69%	14.84%	14.84%
	Career Length	7.75	7.81	7.90	8.77	7.96
All Races	Part. Rate	9.7%	10.23%	10.96%	9.7%	9.7%
	Career Length	6.12	6.19	6.36	7.21	6.30

Table A.19: Military Pay and Promotion Experimental Results

		Baseline	No Racial Civilian Term	Same Ed. Dist.	Altered Trans. Prob.	No Bus. Cycle	Impulse Response
White	Part. Rate	9.36%	9.36%	9.36%	9.07%	8.84%	10.00%
	% of Military	85.16%	90.27%	89.36%	85.36%	85.22%	85.13%
	Career Length	5.84	5.84	5.84	5.71	5.78	5.96
Black	Part. Rate	12.22%	7.56%	8.35%	11.66%	11.48%	13.10%
	% of Military	14.84%	9.73%	10.64%	14.64%	14.78%	14.87%
	Career Length	7.75	7.00	7.19	7.77	7.78	7.75
All Races	Part. Rate	9.7%	9.15%	9.24%	9.38%	9.15%	10.37%
	Career Length	6.12	5.95	5.98	6.01	6.08	6.23

Table A.20: Race and Business Cycle Experimental Results

Name	Symbol	Value	Standard Error
Civilian Wage Shock S.D.	σ_c	0.1588	4.53E-07
Schooling Shock S.D.	σ_s	17,240.2	239.04
Stay Home Shock S.D.	σ_h	20,952.2	59.78
Active Wage Shock S.D.	σ_{at}	0.2771	2.74E-05
Reserve Wage Shock S.D.	σ_r	0.4877	1.38E-04
Civilian/School Corr.	ρ_{cs}	0.7256	1.19E-05
Civilian/Home Corr.	ρ_{ch}	0.0129	6.14E-08
Civilian/Active Corr.	ρ_{cat}	0.6042	1.76E-04
Civilian/Reserve Corr.	ρ_{cr}	0.5785	7.86E-04
School/Home Corr.	ρ_{sh}	0.0788	1.08E-06
School/Active Corr.	ρ_{sat}	0.2491	8.14E-05
School/Reserve Corr.	ρ_{sr}	0.2351	3.72E-04
Home/Active Corr.	ρ_{hat}	0.2824	8.13E-05
Home/Reserve Corr.	ρ_{hr}	-0.0848	8.15E-05
Active/Reserve Corr.	ρ_{atr}	0.7345	1.11E-03
C. Wage Measurement Error	σ_{μ_c}	0.3367	2.08E-07
A. Wage Measurement Error	σ_{μ_a}	0.2334	2.54E-06
R. Wage Measurement Error	σ_{μ_r}	0.7962	6.63E-05
Military Rejection Prob.	π_d	0.0025	0.41
Military Rejection Prob.	π_m	0.0013	9.76E-02
Discount Factor	δ	0.72	2.61E-06

Table A.21: Variance and Probability Parameters

Name	Symbol	Value	Standard Error
Civilian Rental Rate	r^c	8,973.22	16.42
Active Rental Rate	r^{at}	0.8295	
Reserve Rental Rate	r^r	0.2031	
Black C. Rental Rate	$\beta_{b,c}$	-0.1145	2.89E-05
C. Schooling Return	$\beta_{1,c}$	0.0876	7.41E-08
C. Civilian Exp. Return	$\beta_{2,c}$	0.1068	6.25E-08
C. Military Exp. Return	$\beta_{3,c}$	0.0276	2.36E-07
C. Civilian Exp. Sq. Return	$\beta_{4,c}$	-0.0011	1.61E-10
C. Civilian/Military Return	$\beta_{5,c}$	-0.0019	5.91E-09
A. Pay Grade Return	$\beta_{1,at}$	0.1431	4.17E-06
A. Military Exp. Return	$\beta_{2,at}$	-0.0265	2.02E-07
R. Pay Grade Return	$\beta_{1,r}$	0.2722	6.65E-05
R. Military Exp. Return	$\beta_{2,r}$	-0.0548	3.53E-06
C. H.S. Diploma Reward	$\beta_{6,c}$	-1,070.0	5.57
C. College Degree Reward	$\beta_{7,c}$	7,942.0	39.99
C. Persistence Reward	$\beta_{8,c}$	878.4	3.63
C. Sector Search Cost	β_j	-635.0	219.86
Base Pay Constant	$\beta_{0,b}$	5,547.22	91.33
B.P. Pay Grade Return	$\beta_{1,b}$	1,142.27	22.41
B.P. Experience Return	$\beta_{2,b}$	317.35	5.14

Table A.22: Wage, Civilian Sector, and Base Pay Parameters

Name	Type 1	Type 2	Type 3	Type 4
Logit Constant Term	-	-0.6302	-0.4491	-3.157
	(-)	(1.36E-02)	(6.15E-03)	(3.50E-02)
Logit H.S. Diploma	-	-0.7136	-0.2636	-0.0026
	(-)	(1.87E-02)	(5.77E-03)	(1.29E-02)
Logit Black Indicator	-	0.862	0.2367	0.2706
	(-)	(9.68E-02)	(8.88E-02)	(0.20)
Logit AFQT 2 Quartile	-	-0.3927	0.1910	1.914
	(-)	(1.97E-02)	(1.04E-02)	(3.55E-02)
Logit AFQT 3 Quartile	-	-1.499	0.0319	2.208
	(-)	(3.74E-02)	(3.19E-03)	(2.63E-02)
Logit AFQT 4 Quartile	-	-1.108	0.2045	2.986
	(-)	(2.05E-02)	(9.24E-03)	(2.99E-02)
Civil. Skill Endowment	-	-0.9517	-0.4170	0.4536
	(-)	(2.02E-06)	(9.09E-07)	(3.49E-06)
S. Preference Endowment	9,128	-	4,374	21,900
	(1306.53)	(-)	(877.48)	(703.84)
H. Preference Endowment	3,473	11,400	-	10,100
	(115.24)	(2183.21)	(-)	(239.75)
A. Duty Skill Endowment	0.3741	-1.030	0.1033	-
	(8.47E-05)	(6.63E-05)	(3.14E-05)	(-)

Table A.23: Type Parameters

Name	Symbol	Value	Standard Error
School Constant	$\beta_{0,s}$	-29,670	537.74
College Cost	$\beta_{1,s}$	32,160	1,452.76
Graduate School Cost	$\beta_{2,s}$	41,920	2,052.57
College Age 20 Cost	$\beta_{3,s}$	1,001	834.92
School Black Constant	$\beta_{10,s}$	-1,105	4,173
College Age 18 Cost	$\beta_{5,s}$	-8,256	26,604
College Time Cost	$\beta_{6,s}$	-3,997	181.25
H.S. Age 18 Subsidy	$\beta_{7,s}$	27,140	16,677
H.S. Age 19 Subsidy	$\beta_{8,s}$	16,980	12,415
College Return Cost	$\beta_{9,s}$	-26,770	951.51
College Return Cost	$\beta_{10,s}$	-17,030	956.79
Home Constant	$\beta_{0,h}$	-16,500	47.28
Home H.S. Diploma Reward	$\beta_{1,h}$	-1,442	30.03
Home College Reward	$\beta_{2,h}$	10,840	168.58
Home Persistence	$\beta_{3,h}$	29,980	361.10
Home School Transition Reward	$\beta_{4,h}$	9,640	952.20
Home Age 18	$\beta_{5,h}$	16,700	5,718
Home Age 19-20	$\beta_{6,h}$	-2,791	682.07
Home Age 21-22	$\beta_{7,h}$	-1,282	575.45
Home Age 23-24	$\beta_{8,h}$	-419.03	880.33
Home Black Constant	$\beta_{9,h}$	-167.5	1,747

Table A.24: School and Home Sector Parameters

Name	Symbol	Value	Standard Error
Active Duty Non-Pecuniary	β_{at}	17.92	24.68
Active Duty Persistence	$\beta_{5,at}$	733.2	24.00
R. and W. Non-Pecuniary	β_{cr}	-5,892	1,071
R. and W. Persistence	$\beta_{3,cr}$	3,540	597.63
R. and H. Non-Pecuniary	β_{hr}	-3,749	705.76
R. and H. Age 18	$\beta_{3,hr}$	796.0	855.66
R. and H. Persistence	$\beta_{4,hr}$	2,345	380.66
M. Exit Reward Year 4	$\beta_{4,m}$	1,212	552.99
M. Exit Reward Year 5	$\beta_{5,m}$	1,582	1,967
M. Exit Reward Year 6+	$\beta_{6,m}$	1,974	3.63

Table A.25: Military Sector Parameters

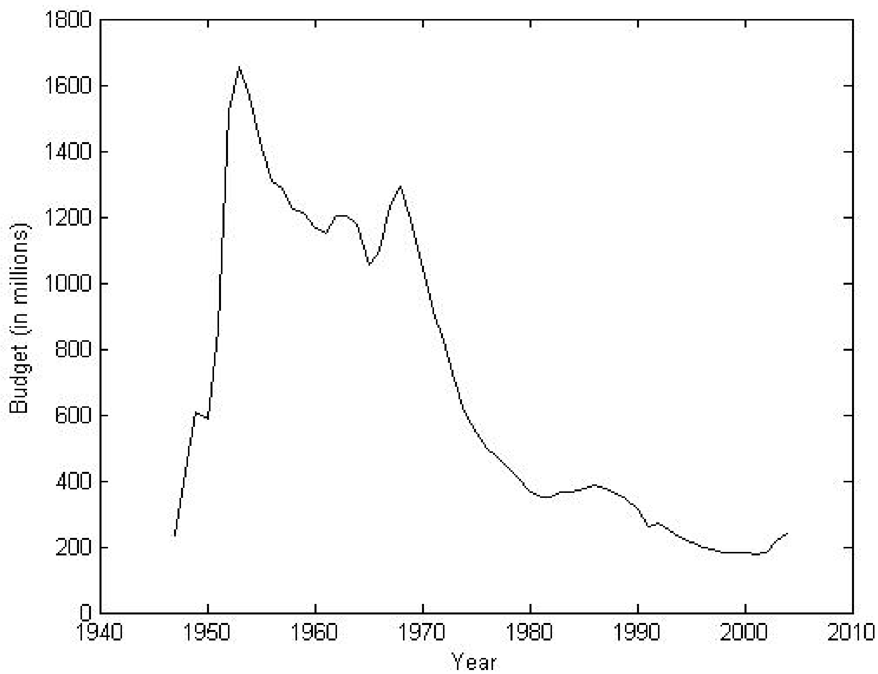

Figure A.1: Real Military Spending 1947-2004

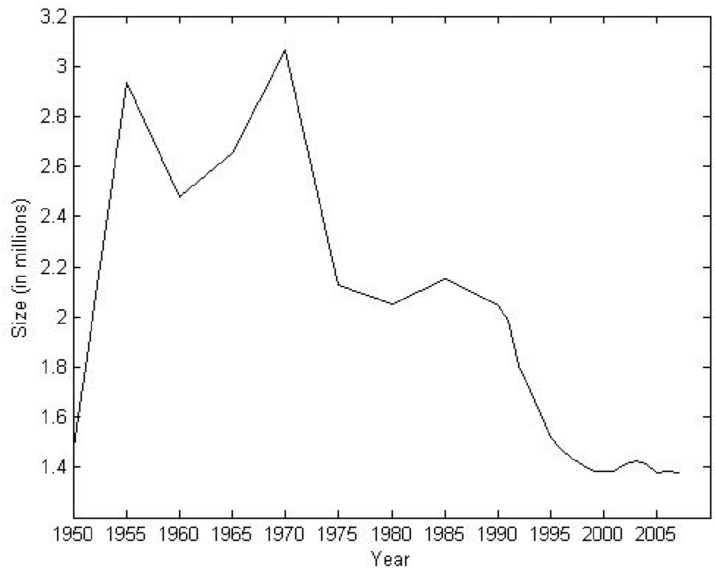

Figure A.2: Active Duty Military Size 1950-2007

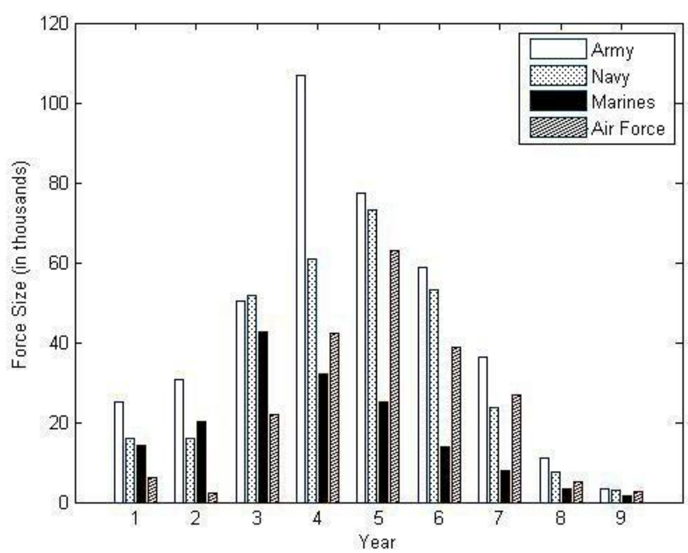

Figure A.3: 2007 Enlisted Rank Distribution

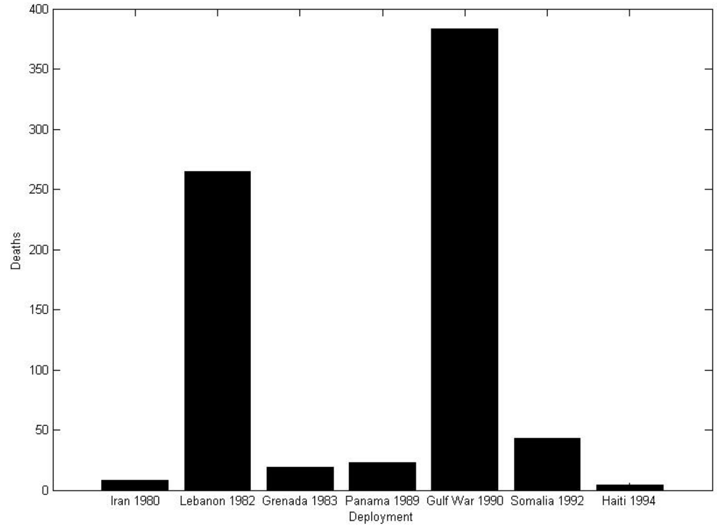

Figure A.4: Military Deaths by Deployment 1980-2000

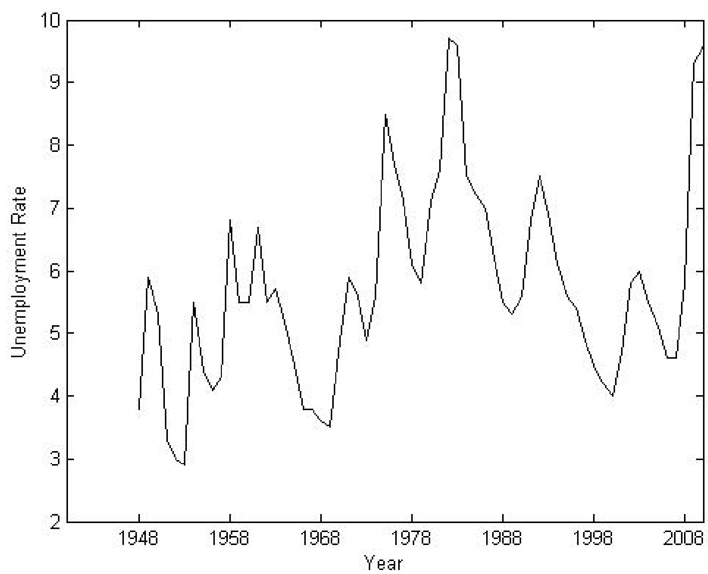

Figure A.5: Unemployment Rate 1950-2007

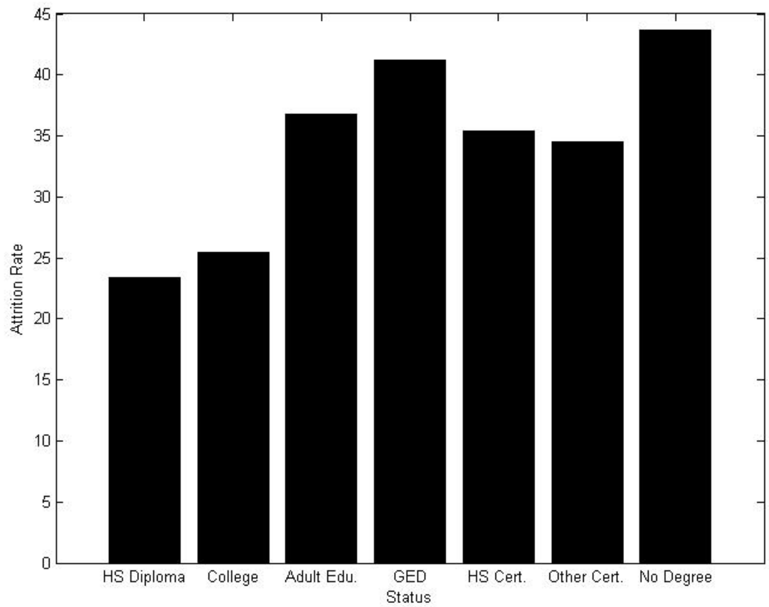

Figure A.6: 1988-1998 24-Month Attrition Rate by Education Status