

THE IMPACT OF COMBAT ON VETERAN WELL-BEING

By

Adam Ackerman

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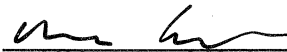
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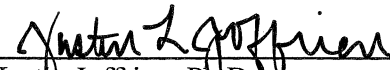
Amos Golan, Ph.D.



Erdal Tekin, Ph.D.



Ryan Sullivan, Ph.D.



Justin Joffrion, Ph.D.



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ABSTRACT

Combat experiences can have formative effects on a veteran's beliefs and behaviors that change well-being in unforeseen ways. This dissertation estimates the impacts of (i) service in war environments and (ii) exposure to traumatic events on three well-being aspects – sexually transmitted diseases (STDs), financial problems (such as bankruptcy), and homelessness – in surviving deployed veterans. Estimations use 1994-2016 data from the National Longitudinal Study from Adolescent to Adult Health and the Millennium Cohort Study, information theoretic methods relying upon minimal assumptions, and exogenous variation resulting from deployment location assignments. Estimations considering only the broader level location assignment, service in a war environment, do not explain individual changes in well-being; however, estimations with the more refined location assignment reveal links between a deployed veteran's exposure to traumatic events and increases in STDs, financial problems, and homelessness. Estimated average effects of combat exposure on each well-being aspect are robust to controls for pre-deployment characteristics, time spent deployed and physical harm. Harmful effects of combat exposure on financial problems and homelessness increase with multiple exposures and poorer pre-deployment health. Harmful effects of combat exposure on STDs appear partly due to increases in substance use and the number of sexual partners, a proxy for relationship stability. Results are relevant to discussions regarding resource needs for military readiness and individuals with past traumatic exposure or increased risk for future traumatic exposure.

STATEMENT OF RESEARCH COLLABORATION

I certify that this dissertation incorporates material that is a result of research collaboration with the Millennium Cohort Study, which requires the participation of additional research members. Chapter 4 is co-authored with Dr. Ben Porter, Naval Health Research Center. Chapter 5 is co-authored with Professor Ryan Sullivan, Naval Postgraduate School, and Dr. Ben Porter, Naval Health Research Center. I initiated research ideas with the Millennium Cohort Study, and I wrote research proposals required by the Millennium Cohort Study. I conducted data analysis, interpretation, and write-ups. The contribution of co-authors is through the provision of data, refinement of ideas, and editing of writing.

I certify, with the above qualification, this dissertation, and the research to which it refers is the product of my own work.

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CHAPTER 1

INTRODUCTION

September 11, 2001 marked the start of the Global War on Terrorism, the longest active war in United States history. War-related operational costs at the end of 2016 have amounted to over \$1.5 trillion, or roughly \$7,200 per taxpayer (Department of Defense 2017). About 2.7 million veterans, considered individuals who served in the military regardless of whether they continue to serve, have deployed overseas (Defense Manpower Data Center 2017). Veterans spent an average of eight months overseas on each deployment, and almost half of deployed veterans completed multiple deployments (US Institute of Medicine 2013). Army, Navy, Air Force, and Marine Corps branches deployed units from Active Duty, Reserve, and National Guard components to Iraq and Afghanistan, other areas designated as combat zones by the President of the United States, and areas in direct support of combat zone operations. Traumatic events for deployed veterans often included improvised explosive devices (IEDs), enemy contact, and casualties. Hostile actions overseas killed 5,389 veterans and physically wounded, commonly in the form of a traumatic brain injury, 52,516 veterans between 2001 and 2016 (Hoge et al. 2008; Defense Casualty Analysis System 2017).

Veterans often think differently about the world after combat experiences. Health officials have diagnosed over seven hundred thousand care-seeking Global War on Terrorism veterans with mental disorders (Veterans Health Administration 2017); meta-analyses of studies on recently deployed veterans estimate post-traumatic stress disorder (PTSD) prevalence of 23 percent and depression prevalence of 13 percent (Fulton et al. 2015; Gadermann et al. 2012). Research also indicates many recent combat zone veterans without traumatic brain injury, PTSD, or depression symptoms experienced lasting neurocognitive declines in memory and sustained attention (Vasterling et al. 2006). While negative mental consequences of combat experiences

have been substantial, psychological research also indicates most trauma exposed veterans, including seven out of ten with PTSD, perceived post-traumatic growth in social relationships, new opportunities, personal strength, spiritual well-being, or life appreciation (Pietrzak et al. 2010; Tsai et al. 2015). As new beliefs can influence many choices, combat experiences are likely to have unintended effects on the production of other aspects of veteran well-being.

This dissertation furthers our understanding of how nearly two decades of often long and repeated combat deployments affected the well-being of surviving veterans. A simple economic model shows how the combat environment could affect the efficiency of individual well-being production, and empirical investigations reduce ambiguity about the expected contribution of combat experiences to well-being. Acute insight about adaptation to adversity comes from looking at sexually transmitted diseases, financial problems (such as bankruptcy) and homelessness. STDs are a lens into problems resulting from risky health behaviors and social relationships, while financial problems and homelessness capture harms not discernable through conventional health and labor market measures. Public health officials, policy makers, and social scientists all have interest in understanding relationships driving sexually transmitted diseases, financial problems (such as bankruptcy) and homelessness, but conclusions about how the combat experiences of (i) service in a war environment and (ii) exposure to traumatic events contribute to these well-being aspects are absent (US Institute of Medicine 2013).

Investigations face empirical challenges. Though incidences of STDs, financial problems, and homelessness each represent a large amount of damage to an individual's well-being, the vast majority of veterans never experience these events. Available data with individual information on recent combat experiences, other relevant deployment factors, and pre-deployment characteristics needed to detect changes in outcomes over time are limited and noisy.

Veterans who deploy overseas also differ significantly from similarly aged counterparts, both outside and within the military, and make comparisons with non-deployed populations problematic (Armed Forces Health Surveillance Center 2007).

Accurate measurements of expected changes in veteran well-being following combat experiences demand safeguards. I use longitudinal data, collected between 1994 and 2016, with pre-deployment, deployment, and post-deployment factors in the analysis of outcomes, and I use deployed veterans as the study population to ensure a valid comparison group. I use the information theoretic, semi-parametric Generalized Maximum Entropy (GME) approach that accounts for uncertainty by not restricting the expected error term to zero. GME multinomial models reduce the sensitivity of estimates to small and noisy real world samples, infrequently observed outcomes, and highly correlated covariates. I also leverage military-induced variation in deployment location assignments, which determine combat experiences, to address potential bias from non-random selection into a combat experience. In assessing how combat experiences may contribute to each outcome, I account for time spent deployed and physical harms in models. I investigate how effects of combat experiences may vary over different time periods and across veterans with different pre-deployment characteristics. I also investigate several combat-related input changes in the production of the sexual health.

Motivation

The motivation for understanding the relationships of combat experiences with STDs, combat experiences with financial problems, and combat experiences with homelessness extends beyond the recently deployed population. About 8 percent of the US population reports experiencing combat or war environments, and the majority of the US population reports

personally experiencing multiple traumatic events¹ (Kilpatrick et al. 2013). The examination of changes in veterans' well-being sheds light on how traumatic events shape individuals and society, and future decision-making profits from an exhaustive understanding of war's past costs and benefits. The knowledge better equips the nation to evaluate engagement in hostile operations as well as efficiently recruit, maintain, and transition an effective fighting force. The high individual and societal costs of STDs, financial problems, and homelessness merit examination.

The burden of poor sexual health is significant. The Centers for Disease Control and Prevention estimates the 20 million new STDs occurring each year account for nearly \$16 billion in healthcare spending, and people under 40 years of age, a population of similar age to recent veterans, account for over 90 percent of gonorrhea and chlamydia cases (Centers for Disease Control and Prevention 2017). In addition to the embarrassment, shame, and stigma associated with an STD that can harm relationships, untreated STDs can result in other serious and permanent health problems, including death (Centers for Disease Control and Prevention 2017). The STD problem within military populations is particularly concerning. Research reports male veterans to be at three times greater odds than non-veterans of having the STD gonorrhea in the past year (Evans et al. 2017), and STDs account for 75 percent of all reportable infectious diseases in the military (Armed Forces Health Surveillance Center 2010). In addition to the

¹ Criteria for traumatic events in referenced study defined in Diagnostic and Statistical Manual of Mental Disorders. Event type categories included accident/fire, disaster, exposure to hazardous chemicals, combat or presence in a warzone, physical or sexual assault, witnessing physical or sexual assault, harm to family member or close friend due to accident or violence, death of a family member or close friend due to accident or violence, witnessing a dead body or body parts, repeated or extreme exposure to aversive details of a traumatic event not through electronic media, television, movies, or pictures unless the exposure is work related, death of a family member or close friend that was not violent or accidental, and other events resulting in an injury, perceived as life threatening, or perceived as extraordinarily stressful. (Kilpatrick et al. 2013)

increased healthcare costs, STDs result in lost personnel time and reduced readiness for the military.

Financial problems indicate potential misjudgments in financial decision-making or adverse changes in financial resources and liabilities, and finances are the leading cause of stress reported by Americans (American Psychological Association 2015). Financial problems can lead to depression, impaired functioning, and poor health (Price, Choi, and Vinokur 2002). Financial problems are also estimated to have depressive effects on individual earnings throughout the following decade (Brugiavini and Weber 2014). Military members typically earn more than civilians with a comparable level of education, but they are not immune from financial problems (Hosek and Wadsworth 2013). The military finds financial problems most prevalent in its junior members, considered those in pay grades E1 to E4, and each year since 2002 more than one in seven junior members has reported serious financial trouble (Hosek and Wadsworth 2013).

The negative impact of financial problems on military organizational readiness has been estimated to outweigh the negative impacts of all other quality of life issues such as a partner's employment opportunities, child care, and health care (Luther et al. 1997). Financial problems translate to significant losses in productivity (Garman, Leech, and Grable 1996; Williams, Haldeman, and Cramer 1996; American Psychological Association 2015), and financial problems harm security. Financial problems have led to multiple cases of espionage (Luther et al. 1997; Fischer 2000; Prados 2010), and roughly 60 percent of security clearance revocations involve financial issues (Defense Office of Hearings and Appeals 2016). Readiness issues can result in a military discharge of an individual, and the subsequent need for additional taxpayer funded investment in recruitment and training (Carlson, Nelson, and Skimmyhorn 2016).

Additionally, unfavorable separations are expected to adversely influence a veteran's acceptability for civilian employment.

Homelessness captures an extreme state of poverty. The homeless, including people whose primary nighttime residence is a supervised shelter for temporary living arrangements, face well-documented negative health consequences, including premature mortality (O'Connell 2005). Homelessness among veterans is troubling. A review of five studies found male veterans between 1.25 and 1.4 times and female veterans between 1.9 and 3.58 times more likely to be homeless than non-veterans (Perl 2015). A 2009 survey found 4 percent of separated veterans with service following September 11, 2001 reported being homeless at least one day in the previous year (Elbogen et al. 2012), and Veterans Administration (VA) data on Operation Enduring Freedom/Operation Iraqi Freedom veterans indicated 1.7 percent used VA homeless programs between 2001 and 2009 (Blackstock et al. 2012). Veteran homeless definitions and estimates exhibit variation, partly because of difficulties in locating all homeless veterans. Estimates still all point to a problem of continual concern with undeniable costs; annual federal spending to address the veteran homelessness problem approached \$1.5 billion in 2015, a 300 percent increase since 2008 (Perl 2015).

Selection Bias

There is evidence STDs, financial problems, and homelessness each represent substantial challenges for veterans and society, but a better understanding of causes requires empirical estimations to address selection bias. While combat experiences can theoretically influence the production of each outcome, any empirically determined differences in a sample could be the result of pre-deployment characteristics. Observable and unobservable characteristics of military service members who deploy overseas differ significantly from similarly aged counterparts, both

outside and within the military (Armed Forces Health Surveillance Center 2007). Basic recruiting standards for cognitive ability, health, and educational attainment separate many civilians from their military counterparts. The 21st century military is also an all-volunteer force, and this suggests differences in unobservable characteristics (*e.g.* risk loving preferences) persist between military and civilian populations. As the 9/11 attacks changed public expectations about US military involvement overseas, military members entering service following the attacks may also exhibit differences from those entering before 9/11. Similarly, although service components have the same entrance selection requirements, those serving exclusively in the National Guard or Reserves may have stronger unobservable preferences for working part-time or living in a particular state (Hirsch and Mehay 2003). Across the military, additional standards (*e.g.* vision requirements for aircrew) and individual preferences (*e.g.* desire to fly) can influence selection of service members into particular branches and occupations. The military is unlikely to use occupations uniformly (*e.g.* send the same number of cooks and pilots) in a deployed combat environment. Because of these selection issues, any association between combat and a later outcome may stem from pre-deployment differences in an observed sample.

Reduction of Selection Bias

The dissertation focuses on deployed service members, and it exploits military induced variation in deployment assignment locations to ameliorate concerns of non-random selection into combat experiences. Several existing works leverage military induced variation in the deployment process in examining the effect of deployment on children's academic achievement (Lyle 2006; Engel, Gallagher, and Lyle 2010), effect of PTSD symptoms on earnings (Heaton and Loughran 2010), and effects of combat experiences on mental health measures (Cesur, Sabia, and Tekin 2013), migraine headaches (Cesur, Sabia, and Tekin 2015), cigarette and

substance use (Cesur, Chesney, and Sabia 2016), and domestic violence (Cesur and Sabia 2016). Estimated effects of combat experiences in past works are conditional upon military branch, rank, occupational specialty and timing of service, but evidence indicates these conditional effects among deployed service members still represent a marked improvement to other approaches. In measuring expected changes in mental health following combat zone service, researchers compared estimations leveraging variation in assignment location within a deployed sample to estimations from other samples that included non-deployed Active Duty military, non-Active Duty military, and civilians. The conditional effect of combat zone service among the sample with the strongest support for a random assignment, *i.e.* the deployed only sample, was 20 percent less than the estimate with the civilian sample and telling of potential non-random selection in combat experiences (Cesur, Sabia, and Tekin 2013).

Two assumptions permit employing the deployment assignment process to reduce selection bias. First, an individual's combat experiences must depend upon his or her deployed location assignment. In other words, an assignment to some locations (*e.g.* Germany) would shelter an individual from combat, while an assignment to other locations (*e.g.* Afghanistan) would expose an individual to some level of combat. The difference in combat experiences is commonly acknowledged between overseas locations inside and outside of designated combat zones, but the levels of risk within combat zones also varies significantly. For example, the 2007 Killed or Wounded in Action (KWIA) rates per thousand deployed members for the majority of countries in a designated US combat zone were at or near zero, while the KWIA rates in Afghanistan and Iraq both exceeded 12 KWIA per thousand deployed members (Pleeter et al. 2011). Though province level casualty rate data is not available, potential for further variation in casualty risk exists within provinces of countries. US service members assigned to southern and

eastern Afghan border provinces and central Iraqi provinces experienced thousands of casualties, while US service members assigned to most other Afghan and Iraqi provinces experienced few or no casualties (White 2016).

The second key assumption is deployment location assignments, conditional on only select observable military characteristics, be plausibly exogenous to individual pre-deployment characteristics. Several aspects of the US military assignment process lend support for the claim (Engel, Gallagher, and Lyle 2010). First, the military normally assigns units, which most commonly contain over 100 service members, rather than individuals, to deploy to a location to engage in combat. Next, the two criteria, (i) unit readiness and availability and (ii) the urgent operational needs of the security environment, used by the Human Resources Command (HRC) for unit deployment assignments do not include sexual behaviors, financial problems, or housing situations of service members (Department of the Army 2010). Unit readiness and availability is assessed by macro-level equipment status, occupational skill sets, and completed training (Department of the Army 2010). Furthermore, the HRC, as a rule, considers neither individual nor average unit features (*e.g.* debt levels, risk preferences, mental toughness, *etc.*) in its deployment decisions (Engel, Gallagher, and Lyle 2010). From an economic perspective, the military views service members with the same rank and occupational specialty to be essentially “perfect substitutes” for deployment location assignments (Cesur and Sabia 2016). The second criterion, urgent operational needs of the security environment, results from continually evolving world events. The pace of evolution means deployment location assignments change with little advance notification, sometimes only a few days or hours. Standard four to six year military service contracts limit individual insight about future deployment locations at time(s) of enlistment, and a non-deployed individual cannot alter security situations in overseas locations

that would change his or her assignment for a future deployment. Finally, an individual has limited influence on his or her unit assignment. The process of assigning individuals to units is separate from the much shorter deployment assignment process. The process of assigning individuals to units occurs only every three to four years, and a recent article underscores the primacy of military requirements that permeate assignment processes:

“The ‘needs of the army’...captures the essence of all assignments: world events drive army assignments. [T]he timing of the move and assignment of a soldier to a subordinate army unit are largely independent of a soldier’s preferences... [O]nce a soldier is assigned to division, the division assigns the soldier to one of several brigades, the brigade assigns the soldier to one of several battalions, and the battalion assigns the soldier to one of several companies. The ‘needs of the army’ also determine the missions that a soldier’s company receives.” (Lyle 2006)

The nature of the deployment assignment process makes it theoretically plausible individual pre-deployment characteristics, other than military branch, rank, occupation, and timing of service, do not predict assigned deployment locations. In previous studies, empirical estimations provide further support for the exogenous deployment assignment assumption. In estimating the effect of deployment-induced parental absences on children’s academic achievement, Lyle (2006) and Engel et al. (2010) exploited variation in the timing of unit deployments and used unit deployment as an instrumental variable for individual deployment. They found estimates of the effect of deployment with the instrumental variable similar to those with the individual deployment variable. Additionally, they found controlling for all information visible to the HRC in administrative records (rank, occupation, age, race, cognitive test score, and educational attainment) had little influence on the estimated effect of deployment. As much as patterns in observable characteristics may guide patterns in unobservable characteristics, the set of findings suggests deployment assignments are independent of individual and family characteristics.

In estimating the effect of PTSD symptoms on reservist earnings, Loughran and Heaton (2010) exploited variation in deployment location assignments between 2003 and 2006 and used country location as an instrument for PTSD symptoms. Summary statistics of background characteristics, including aptitude and pre-deployment health, for reservists deployed to Iraq and Afghanistan were generally similar to summary statistics for reservists deployed to lower risk locations; however, pre-deployment civilian earnings of reservists deployed to Iraq, Afghanistan, and Kuwait were about four thousand dollars less than pre-deployment civilian earnings of reservist deployed to low risk areas. Weaker labor market prospects inducing some reservists to volunteer for deployment, which occurred with a greater frequency to high-risk areas during the study period, is one possible explanation for the earnings difference. The researchers determined in discussions with defense manpower experts that the location assignment, conditional on rank and occupation, was likely to be exogenous for the involuntarily deployed, though the possibility of a small number of reservists successfully volunteered for a deployment to a particular location could not be ruled out. As any number of volunteers would be small relative to the population of deployed reservists, the researchers concluded any expected bias would also be small. As a control, researchers conducted the instrumental variable estimation with a first-differenced specification to address potential bias resulting from any unobserved heterogeneity. The instrumental variable estimation indicated PTSD symptoms resulted in a 4 percent decrease in short-run annual earnings; similar to the estimates obtained via fixed effects and ordinary least squares estimations. The results lend support for the hypothesis that location assignment is plausibly exogenous to individual characteristics other than military branch, rank, and occupational specialty.

In estimating the effects of combat experiences, conditional on military branch, rank, occupational specialty, and timing of service, on mental health (Cesur, Sabia, and Tekin 2013), migraine headaches (Cesur, Sabia, and Tekin 2015), cigarette and substance use (Cesur, Chesney, and Sabia 2016), and domestic violence (Cesur and Sabia 2016), researchers exploited variation in deployment location and conducted estimations with an even wider range of individual and family characteristics. Prior to estimating effects of combat experiences, the researchers conducted regressions of individual deployment location on observable background characteristics. They found, conditional on military branch, rank, occupational specialty, and timing of service, that deployment assignments to both (i) combat zones and (ii) locations exposed to hostilities within a combat zone were orthogonal to nearly all observable background characteristics among those with deployed service. Cesur, Chesney, and Sabia (2016) stressed the recurring exception, combat assignments being more likely for men than women in their 1994 to 2008 sample data, was in line with US military policies from 1993 to 2013 excluding women from many combat operations, including support of ground combat, and a Defense Department estimated 20 percent of all military assignments. Additionally, estimated effects from regression specifications restricted to each background variable did not explain deployment locations and estimated effects of combat exposure from regression analyses restricted to the male sample did not change the pattern of results. The additional analysis led researchers to not view gender as a sign of endogenous selection (Cesur, Sabia, and Tekin 2013; Cesur, Chesney, and Sabia 2016). Although the data did not contain unit deployment information needed for an instrumental variable analysis, the researchers found estimated effects of combat experiences with their complete set of observable background variables, which included information visible to the military HRC as well information on the parents and individual from adolescence, varied

no more than about 2 percent to estimated effects with only the conditional military characteristics. Though assumptions about unobservable characteristics are unverifiable, the set of findings makes it reasonable to believe deployment assignments are conditionally independent of individual and family characteristics.

Overall, military regulations and existing studies suggest, conditional upon military branch, rank, occupation and timing of service, individual pre-deployment characteristics do not directly determine assigned deployment locations. Since an individual's combat experience must depend upon his or her deployed location assignment, it follows combat experiences only relate to individual branch, rank, occupation, and timing of service. In this manner, the assignment process can help overcome potential non-random selection of deployed service members into combat. As individual characteristics may influence the branch, rank, occupation, or timing of an individual's military service, it is important to emphasize regression estimates of combat experiences relying upon conditional randomization do not capture possible second order effects of conditional characteristics included as control variables. Estimated effects of combat experiences are also relative to deployments without combat, rather than relative to no deployment. Still, the focus on those most likely to deploy provides estimates pertinent to policy decisions about engaging in combat operations.

Limitations

The dissertation has several limitations. First, the population of interest, deployed US military members, differs on many dimensions from other military and civilian populations. Second, the battlefield settings differ on many dimensions from the settings of other traumatic events, including other wars. While generalizations of findings to other populations and settings

may not be appropriate, the continual nature of many recent military overseas operations makes understanding changes in the well-being of deployed veteran relevant to current policy decisions.

Though the dissertation considers several distinct measures of well-being, the measures do not constitute a holistic assessment of overall well-being. Generalizations of findings from these outcomes to other well-being measures may not be appropriate. The intent of selected measures is to capture behavioral and functional consequences not discernable from other studies on combat.

Analyses with observational data also face threats to internal validity. Though safeguards exist to ensure accuracy of data sources (see Chapter 3 and Chapter 4 for details), survey data may produce biases related to attrition and misclassification of combat experiences and outcomes because of self-report. Combat introduces survival bias in the sample data because those most severely affected mentally and physically may no longer be able to recall information or participate at follow-up periods. The expected consequence is negatively biased estimates of combat experiences on outcomes, where any positive estimate can be interpreted as a lower bound. Self-reported measures may not represent true levels due to social desirability bias, and whether social desirability bias varies among veterans with and without combat experiences is unknown. Reported combat experiences could also co-occur with unobserved deployment experiences, such as an undiagnosed traumatic brain injury, that influence well-being production, but many observed deployment experiences, including time spent deployed and known physical harms, are included as estimation controls. Though observational data are not without limitations, the longitudinal aspect of the data is a major strength that allows evaluation of temporal sequences from reported combat experiences to different outcomes.

The real-world variation in timing of combat assignments and outcome measurement results in an estimation focus on net effects. The time lapses between combat experiences and outcome measures mean combat experiences may have consequences in a potentially limitless number of domains and complicate measurement of a direct causal effect. Estimates capture direct and indirect effects of combat assignments, but the upside is such estimates may actually better reflect real life than controlled laboratory estimates.

The observational setting also means the threat of unobserved differences existing in the group with combat experiences and group without combat experiences is omnipresent. Even with a known location assignment process and an empirical balance of observed characteristics, it is important to remember deployed military service involves complex human interactions. Unobserved characteristics may have encouraged some veterans to “self-select” to a more or less dangerous area within an assigned deployed location. The observational setting weakens the ability to make definitive conclusions about causality without a synthesis of evidence supporting inferences. As experiments with combat experiences are neither ethical nor practical, analyses of relationships between combat experiences and well-being aspects neglected by previous research provide starting points for further related research.

Overview

This dissertation presents new evidence on how war environments and traumatic events influence veteran well-being. In Chapter 2, I provide a conceptual framework to understand why combat experiences may influence veteran well-being. I then identify gaps in the existing literature on the well-being of combat veterans. Chapters 3-5 present empirical estimations. Unlike much previous work on veteran well-being, I focus on reducing potential bias from non-random selection into combat experiences and on detecting individual changes in outcomes

following combat experiences. I conduct estimations with National Longitudinal Study of Adolescent to Adult Health and Millennium Cohort Study data to show empirical support for the conditional randomness of military location assignments. I use information theoretic methods to reduce the sensitivity of estimates to small and noisy real world samples, infrequently observed outcomes, and highly correlated covariates. I demonstrate robustness of estimates for the influence of combat experiences on the production of veteran well-being with a wide range of controls for environmental, family, and individual characteristics.

Specifically, Chapter 3 addresses whether combat experiences contribute to veterans acquiring STDs, a previously unstudied outcome. While combat zone assignment alone does not explain changes in STDs among deployed veteran, the results indicate a deployed Active Duty veteran assigned to a combat zone with combat exposure is more likely to acquire an STD than a veteran assigned to a combat zone location without combat exposure. The finding on combat exposure is robust to estimations with only veterans serving after 2001 and to estimations with deployment length and physical harm controls. Additional estimations find combat exposure positively associated with poor mental health, substance use, and the number of recent sexual partners, a proxy for relationship stability. Regressions do not indicate poor mental health is a likely pathway from combat exposure to STDs, but regressions do provide suggestive evidence that substance use and relationship stability serve as pathways from combat exposure to STDs.

Chapter 4 addresses whether combat experiences lead to the production of financial problems, also a previously unstudied outcome. Though an assignment to a war environment does not explain changes in economic well-being, the results show an assignment with combat exposure increases the predicted probability of a deployed veteran developing both financial distress and a major financial problem. Furthermore, the estimated effect of combat exposure on

financial decline increases with multiple exposures and poorer pre-deployment health. Estimates are robust to alternate combat exposure measures. Additionally, a falsification test comparing estimates of combat exposure with estimates of a deployed experience, burning waste, unlikely to be causally related to financial declines suggests traumatic events drive observed financial declines.

Chapter 5 addresses whether combat experiences place veterans at a greater risk for homelessness. Though an assignment to a war environment does not explain changes in the probability of homelessness, the results suggest an assignment with combat exposure increases the predicted probability of a deployed veteran experiencing homelessness. The results are robust to a variety of specifications and different measures of homelessness. Additionally, the estimated effect of combat exposure is greater for veterans with multiple combat exposures, veterans in their 20s, and veterans with poorer pre-deployment health.

Chapters 3-5 each end with a discussion of respective results. Chapter 6 summarizes findings, highlighting patterns and relevance to economic theory and policy. Chapter 6 concludes with implications for future research.

CHAPTER 2

CONCEPTUAL FRAMEWORK AND RELATED LITERATURE

The chapter first presents a framework to organize and distinguish ideas about the influence of combat experiences on veteran well-being. The chapter then covers relevant past empirical work on the relationship between combat experiences and veteran well-being, and it highlights knowledge gaps in research on sexual health, financial problems, and homelessness.

Conceptual Framework

Service in war environments and exposure to traumatic events test veterans with extreme circumstances; these tests have formative effects on the beliefs and behaviors of veterans. The framework explains how knowledge and traits embedded by combat experiences may alter the efficiency of individual well-being production.

The framework's production process follows Becker's theory of the allocation of time (Becker 1965; Michael and Becker 1973). Individuals, subject to resource limitations, produce commodities desired for consumption with a combination of nonmarket time and market goods and activities. For example, the production of good sexual health could result from time spent engaging with different people in sexual relations as well as time and money spent in purchasing condoms. Similarly, the production of economic well-being or an established residence could result from both nonmarket and market decisions such as marriage, children, health, and work. The commodities produced determine an individual's utility, while the nonmarket time and market goods and activities provide utility only indirectly through their use in the production of commodities.

The efficiency of commodity production may be affected not only by individual characteristics, but also environmental variables (Michael and Becker 1973; Rosenzweig and

Schultz 1982; Grossman 2006). An environmental variable is different from direct inputs in production because environmental variables do not use up available resources in production. Rather, an environmental variable changes an individual's understanding of the true production process. The knowledge of relative input productivity and relative input prices determines individual production choices. One input is better than another input if the input yields more output at lower price. If an environment heightens knowledge of available inputs or the optimal combination of inputs, then a better choice of inputs, or allocative efficiency, implies better output. On the other hand, if an environment degrades knowledge of available inputs or the optimal combination of inputs, then a worse choice of inputs implies a worse output.

Similar to empirical studies of education's influence on non-market production (Grossman 2006; Chevalier and Feinstein 2006; Lochner 2011; Cannonier 2012), only a simplified model is needed to capture relevant concepts. First, a production function shows the influence of input decisions and all other factors:

$$Y = f(C, X) \quad (2.1)$$

where Y represents some commodity production relevant to an individual's well-being. Since actual levels of Y are unobserved, commodities are viewed as latent variables. The failure to reach a production threshold for good sexual health, economic well-being, or an established residence results in an observed STD, financial problem, or homelessness. The vector C represents production choices involving market and non-market resources, and the vector X represents all other production characteristics (*e.g.* age, gender). Next, a function shows the influence of an environmental variable on choices:

$$C = g(E, X) \quad (2.2)$$

where E represents an environmental variable that does not influence vector X . Finally, the substitution of equation 2.2 into equation 2.1 produces:

$$Y = f(g(E, X), X) = h(E, X) \quad (2.3)$$

Equation 2.3 provides the basic framework I use to capture the influence of combat experiences on veteran well-being. The war environment and traumatic events represent environmental variables that change how a veteran understands the processes leading to outcomes. The model is useful for identifying and describing overall changes in observed outcomes, and the framework recognizes the multiplicity of input choices involved in production.

While the framework provides a plausible explanation for why combat influences outcomes, measuring whether allocative efficiency changes with individual outcomes is impracticable with available data. An empirical test of allocative efficiency requires observing all input decisions in the true production function for each outcome. Combat experiences could instead alter the marginal products in a given set of direct inputs, thereby changing productive efficiency; however, perceived marginal products are also unobservable (Rosenzweig and Schultz 1982). Putting aside empirical challenges of testing whether efficiency changes are a true cause of the influence of combat experiences, I explain reasons combat experiences are likely to affect efficiency changes in veteran well-being production.

One reason is rules differ for combat operations. The first military order given to veterans entering a combat zone contains prohibitions to ensure order and discipline in the war environment, and veterans violating prohibitions may face administrative, non-judicial or judicial action under the Uniform Code of Military Justice (Lee 2015). Relevant prohibitions include gambling of any kind, alcohol use, any controlled substance use without a prescription, pornographic media, sexual contact of any kind with local or foreign nationals who are not

members of coalition forces, and cohabiting, residing or spending the night with members of the opposite sex, except lawfully married spouses (Lee 2015). Veterans could learn improved health and decision making in a combat zone due to the near abstinence of many common risky health behaviors, but veterans could also have fewer opportunities to recognize consequences of risky health behaviors. For example, veterans may forget about the chances of STDs occurring with sexual activity or the impaired judgement occurring with alcohol or drug use (Eckardt et al. 1998). Rules in war environments also permit veterans to take some actions, often involving deadly force, considered illegal in most other environments. Veterans may develop feelings of invincibility and learn to disregard civil frameworks; however, the chaos of war could also lead veterans to recognize human frailty and achieve a greater appreciation for civil legal frameworks. In any case, combat orders and rules teach veterans new ways to approach situations and may influence decisions affecting veteran well-being outside of combat.

Veterans also experience considerable stress in combat due to oft-repeated lethal, as well as other pressing, decisions and traumatic exposures. The stress of combat experiences can affect both the bodies and minds of veterans. Physical wounds or injuries will limit the ability to produce many factors of production, but the effects of mental stress on production are less clear.

Increased mental stress may lead to degraded mental health and a limited awareness of the optimal set of production inputs. Estimates suggest nearly one fourth of returning Global War on Terror veterans encounter mental health problems, commonly some combination of PTSD and depression (US Institute of Medicine 2013). Veterans with PTSD relive traumatic experiences through intrusive, recurrent recollections, flashbacks, and nightmares; studies consistently find veterans with PTSD display deficiencies in memory and sustained attention (Dolan et al. 2012). Veterans with depression commonly feel sad or hopeless for extended

periods, and depressed individuals can have problems adapting to changing contingencies, particularly in social settings (Cella, Dymond, and Cooper 2010; Destoop et al. 2012). Even combat veterans without PTSD or depression symptoms may display deficiencies in memory and sustained attention (Vasterling et al. 2006). Degraded cognitive abilities and negative emotions may lead combat veterans to make decisions not in their best interest.

While physical and mental harm following combat experiences suggest less efficient production of well-being, the stress of combat can also produce positive adjustments to mental health that may countervail productive inefficiencies. Combat experiences more commonly generate post-traumatic growth than PTSD, and veterans with PTSD are more likely than other veterans to report post-traumatic growth (Pietrzak et al. 2010; Tsai et al. 2015). Post-traumatic growth involves perceived improvements in functioning; people report improved relationships, greater sense of personal strength, and the ability to recognize new possibilities or life paths. The positive reports may simply be a form of coping (Frazier et al. 2009), but self-perceived growth may in some cases produce actual functional improvements leading to greater awareness of the optimal set of production inputs.

As there is potential for considerable variation in individual responses to combat experiences, expected efficiency changes in the production of well-being are ambiguous. Additionally, institutional care and entitlements may asymmetrically influence veterans with different deployment experiences. For example, enemy actions during combat are designed to harm veterans, and veterans with combat experiences may require more healthcare than veterans without combat experiences. If care does not restore physical or mental health, service related disabilities entitle separated veterans to compensation, separate from unemployment compensation for veterans, designed to replace earnings due to productivity losses (US Institute

of Medicine 2013). Additional institutional care and entitlements could distort any harm due to combat experiences. Given the complex influences of combat experiences on well-being, the expected overall theoretical change for STDs, financial problems, and homelessness is ambiguous and motivates empirical investigation.

Related Literature

This section reviews the relevant literature to demonstrate knowledge gaps in the empirical relationship between combat experiences and measures of well-being. It examines related research on mental health and risky health behaviors, and then looks at research on sexual health and economic well-being.

Health Outcomes

As advances in medicine have produced unprecedented reductions in battlefield deaths (Kotwal et al. 2011), there has been a growing interest in the health of returning veterans. Research indicates combat exposure precipitates the development of PTSD, and factors such as deployment length and exposure intensity are associated with further declines in mental health (Holdeman 2009; US Institute of Medicine 2013; Cesur, Sabia, and Tekin 2013). The evidence for increased smoking and illicit drug use following combat exposure is also now substantial (Killgore et al. 2008; Jacobson et al. 2008; Hooper et al. 2008; Thomsen et al. 2011; T. C. Smith et al. 2011; Hoerster et al. 2012; Garyn-Tal and Shahrabani 2015; Cesur, Sabia, and Tekin 2015).

Methodological and data concerns plagued early studies and created difficulties in determining whether combat experiences contributed to adverse outcomes. Such determinations are important for social scientists and policy makers because eligibility for assistance and disability programs can hinge on whether health conditions are connected to combat service or exposure (Department of Veterans Affairs 2010; Stojetz 2014). Social scientists argued early

studies were merely descriptive, relied upon small and often non-random samples, and failed to control for both observable and unobservable pre-deployment characteristics (Cesur, Sabia, and Tekin 2013; Cesur, Chesney, and Sabia 2016). Recent works, relying on the plausible exogeneity of the military deployment assignment process and detailed longitudinal data, claim to have addressed these concerns and provided robust evidence on the role of combat exposure (Cesur, Sabia, and Tekin 2013; Cesur, Chesney, and Sabia 2016).

Researchers have given less attention to the relationship between combat experiences and sexual health, and concerns exist regarding methodology and data. No studies I found in the literature review examine the relationship between combat exposure and STDs, although one study did examine the relationship between combat deployment and risky sexual activity (Thomsen et al. 2011). Relying upon retrospective responses of 2,116 Active Duty sailors and marines to the 2006-2007 Naval Health Research Center Combat Stress and Substance Use survey, the study compared individual civilian, pre-deployment and post-deployment risky sex with McNemar's statistical tests for paired data and used regression estimations of risky sex to compare deployed and non-deployed veterans. The study's within-subject and between-subject analyses both failed to reject the hypothesis that unprotected sex with someone other than a regular partner would increase following a combat deployment. The lack of specific measures for traumatic and other deployment experiences may have masked important heterogeneity within combat deployment. The analyses also did not include members from all branches or those who already left the military, a group more likely to suffer from mental health problems associated with combat (Heaton and Loughran 2010).

Economic Well-being

Economists often look to earnings or income as indicators of economic well-being, and several studies examine the relationship of earnings or income with combat experiences. Reports on disability compensation suggest compensation replaces expected lifetime earnings for most deployment injuries, but those with a primary mental or less severe disability may not be fully compensated (Christensen et al. 2007; Heaton, Loughran, and Miller 2012). A limitation of these reports is not separately capturing how combat deployments and combat exposure may affect outcomes. The 2010 National Survey of Veterans provides information on combat exposure, VA disability rating, and household income, and an economic analysis finds combat exposure among post-9/11 veterans to not be associated with reduced household income (Edwards 2015). Still, the analysis only compares deployed and non-deployed veterans with a small cross-sectional sample lacking occupational category information, institutionalized veterans and homeless veterans.

Earnings or income measures also provide limited understanding of economic well-being. Neither earnings nor income provides indications about spending, borrowing, or savings activities needed to assess whether earnings or income, including government transfers, are adequate for economic well-being. Earnings or income-based poverty lines can help identify individuals in an extreme state of poor economic well-being, but literature review uncovered no studies examining the relationship between combat experiences and poverty. Additionally, poverty lines are contentious due to determination of the appropriate line level and potential income measurement errors (Ravallion 1996; Nicoletti, Peracchi, and Foliano 2011). The supplementary use of alternative objective and subjective economic well-being measures can highlight policy relevant aspects of economic disadvantage (Deaton 2010; Ayllón and Fusco 2017). Alongside the analysis of income among post-9/11 veterans, Edwards (2015) conducted

parallel analyses of a range of socio-economic measures, such as homeownership, employment, marital status, and education. Still, the analyses suffer from same limitations as the analysis of income and leaves the picture of veteran economic well-being incomplete.

Analysis of financial problems among recent veterans can help complete the picture, but research on the relationship between financial problems and combat experiences are lacking. Existing studies focus on associations between financial problems and other post-deployment problems (Adler et al. 2011; Elbogen et al. 2012). While PTSD (Adler et al. 2011; Elbogen et al. 2012), suicidal ideation, alcohol abuse, drug misuse, self-harm behavior, criminal arrests, severe violence, physical aggression, and homelessness (Elbogen et al. 2012) are all associated with measures of post-deployment financial problems, the lack of pre-deployment information in existing studies precludes insight as to whether financial problems are attributable to combat experiences. Additionally, past studies limit focus to those currently serving (Adler et al. 2011) or separated (Elbogen et al. 2012).

While there is also interest in homelessness resulting from combat experiences, there is a similar dearth of research. Studies of veterans looking to military experiences as risk factors for homelessness have not yielded clear conclusions. A study of World War II, Korean War, and Vietnam War veterans using VA services between 1988 and 1992 found that wartime service, combat exposure, and PTSD were not more prevalent among homeless veterans than non-homeless veterans (Fullerton and Ursano 2009). However, research with a nationally representative survey of Vietnam veterans found an association between higher levels of combat stress and reports of past homelessness (Fullerton and Ursano 2009). More recently, a study of post 9/11 veterans who used VA services found Operation Enduring Freedom/Operation Iraqi Freedom deployed personnel had a 34 percent higher risk for homelessness than non-deployed

personnel (Metraux et al. 2013). The research also found behavioral health disorders, including PTSD, to be significant risk factors of homelessness, though the study did not measure or adjust for combat exposure (Metraux et al. 2013). Separate research on 994 homeless Operation Enduring Freedom/Operation Iraqi Freedom/Operation New Dawn veterans referred to the VA supportive housing program between January 2008 and April 2011 found the majority of these veterans reported combat exposure and had been diagnosed with PTSD (Tsai, Pietrzak, and Rosenheck 2013).

The homelessness studies have common limitations. The focus is on veterans separated from the military, and homelessness occurring during service is ignored. The study samples are limited to either the estimated 17 percent of homeless veterans using VA services or small cross-sectional samples inappropriate for making significant inferences (Tsai et al. 2016). Many studies only look at Vietnam and earlier era veterans, populations different from the recent all-volunteer force engaged in more unconventional warfare. Additionally, among studies comparing groups of veterans, none addresses the issue that non-deployed service members may not be an appropriate control group for deployed service members due to selection factors. Past studies also do not consider the sensitivity of their estimates to different definitions or durations of homelessness. Though the literature indicates concern about the relationship between recent overseas operations and homelessness is growing, the degree combat experiences are associated with homelessness remains unclear.

Summary

Veterans learn from combat experiences, and the new understanding may help or harm the production of individual well-being. Previous research emphasizes the importance of measures and methodology in assessing improvements and declines in veteran well-being

following combat experiences. Researchers have not looked at the relationship of combat experiences with many important aspects of veteran well-being, including STDs and financial problems. Additionally, much past work on veteran well-being, including studies on homelessness, does not measure changes over time or account for underlying population differences. In the remaining chapters, I present empirical analyses overcoming the limitations of much previous work.

CHAPTER 3

COMBAT AND SEXUALLY TRANSMITTED DISEASES

This chapter shows how combat experiences are associated with changes in the probability of acquiring an STD. The chapter introduces the sample data. Then, it presents the estimation strategy, main results, checks of robustness, and an exploration of potential pathways from combat exposure to an STD. The chapter concludes by discussing the potential costs associated with combat experiences.

Data: National Longitudinal Study of Adolescent to Adult Health

The National Longitudinal Study of Adolescent to Adult Health (NLSAAH, more commonly referred to as Add Health) was designed to understand forces that influence adolescent health and risk behaviors, and it is the largest, most comprehensive survey of adolescents ever undertaken. The study contains a nationally representative sample of adolescents in seventh through twelfth grade for the 1994-1995 school year, when researchers collected the first wave of data. The primary sampling frame included 80 high schools representative of US schools with respect to region of country, urbanicity, size, type, and ethnicity. In order to include junior high or middle school students, feeder schools were also selected to generate a pair of schools in 80 different communities. More than 90,000 students completed an in-school questionnaire, and the Wave I in-home baseline survey obtained response data from 20,745 of the adolescents between ages 11 to 18. A parent, preferably the resident mother, was also asked to complete a survey on each adolescent. The goals of the study expanded to include adult outcomes as the cohort aged, and there have been three follow-up waves of the survey (Wave II in 1995-1996, Wave III in 2001-2002, Wave IV in 2007-2008). The Wave II follow-up excluded the twelfth grade respondents from Wave I, and it obtained

response data from 9,795 of the original participants. Wave III and Wave IV considered all those completing the Wave I in-home survey. The Wave III follow-up obtained response data from 15,170 of the original participants, while the Wave IV follow-up obtained response data from 15,701 of the original participants. Survey topics during each wave included social, economic, psychological, and health circumstances of the respondents (see Harris 2013 for more detailed information on NLSAAH).

The data collected has unique features that make it well suited for analysis. First, it includes a sample of veterans with detailed information on overseas service and pre-deployment characteristics. Second, it collects retrospective information on sensitive topics, such as sexual activity, using computer-assisted self interview (CASI) technology in the respondent's home to enhance the sense of privacy for respondents.

Analysis limits the sample in several ways to ensure a valid comparison group. The sample includes males providing information on sexual activity at the Wave I and Wave IV interviews and reporting previous overseas Active Duty military service in the Army, Navy, Air Force, or Marine Corps at the Wave IV interview. The complex relationship between gender and risk preferences, sharp gender differences in STD prevalence and risk factors among veterans, and the small share of females within the military translating to a small sample reporting an STD motivates the focus on male veterans (Eckel and Grossman 2008; Stahlman et al. 2014). Similarly, those indicating exclusive service in the Reserves, National Guard, or Coast Guard may bias estimates and do not represent samples large enough for independent analysis. Based upon these selection criteria, the initial sample for analysis includes 485 male veterans.

Sexually Transmitted Disease Measures

Outcome measures for STDs are created from responses to questions about having been told by a clinician that they have gonorrhea, chlamydial infection, syphilis, trichomoniasis, genital warts, herpes simplex virus, or HIV/AIDS. The binary variable *STD* refers to whether the respondent had ever been diagnosed with any of the listed diseases, while the binary variable *Past year STD* refers to whether the respondent had been diagnosed in the past year with any of the listed diseases. For context, Table 3.1 displays descriptive statistics for available measures of Wave I and Wave IV STDs in NLSAAH populations. At the Wave I interview, fewer than two percent of all individuals report STDs. While approximately 13 years later at the Wave IV interview, STDs affected nearly one in six of all respondents with more than one in twenty reporting an STD in the past year. In veterans with Active Duty overseas service, column 5 shows 14.6 percent report being ever diagnosed with an STD (all since the Wave I interview) and 5.4 percent report being diagnosed with an STD in the past year.

Table 3.1 Description of STD outcomes by Military Status for Male Respondents.

	(1)	(2)	(3)	(4)	(5)
Variable	All Respondents	All Civilian	All Military	Active Duty Overseas=0	Active Duty Overseas=1
<i>STD</i> – Wave I	0.015 (0.12)	0.016 (0.12)	0.008 (0.09)	0.020 (0.12)	0.000 (0.00)
<i>STD</i> – Wave IV	0.144 (0.35)	0.141 (0.35)	0.166 (0.37)	0.195 (0.35)	0.146 (0.35)
<i>Past year STD</i> – Wave IV	0.059 (0.24)	0.059 (0.24)	0.059 (0.24)	0.065 (0.23)	0.054 (0.23)
Observations	7081	6247	834	349	485

Standard deviations in parentheses. Unweighted means generated using Waves I and IV of NLSAAH.

The use of self-reported, clinically diagnosed STDs are well suited for analysis. Though diagnosed STDs require healthcare services, military service requires periodic health assessments (required within a 15 month window from previous assessment and pre-/post-deployment) that cover sexual health and ensures pre-deployment and biannual HIV screening (Deiss et al. 2016). Veterans who separate from the military may still have different levels of

healthcare use and access, but controls for health insurance status and frequency of routine check-up are included in all estimations to address these concerns. Self-reported STD diagnoses capture diseases diagnosed outside the military health care system and of an asymptomatic nature (*e.g.* chlamydial infection). Compared to other measures of risk taking such as paid sex that can be safe, legal, and represent variable risk levels within a population, STDs offer easier comparisons across populations and represent actual past harmful behavior. As no members of the deployed sample reported an STD at Wave I, the measures also capture individual changes over time.

One potential downside is prior research with an NLSAHH sample containing laboratory confirmed STDs suggests self-reported sexual outcomes suffer from under-reporting, though the research importantly did not find any correlates to discrepant reporting (DiClemente et al. 2011). As long as the reporting biases in STDs are orthogonal to measures of combat, valid estimates of combat can still be obtained.

Estimation Strategy

The estimation goal is to understand how much combat experiences contribute to the probability of acquiring an STD. Valid estimations need to control for differences between individuals who do and do not experience combat. The randomness of military deployment location assignments theoretically eliminates confounding from individual pre-deployment characteristics, other than a few observable military characteristics. Empirical tests first determine whether the theoretical assumption of conditional random assignments is plausible. Then, the empirical framework and estimation methods to assess the effects of combat experiences on acquiring an STD are detailed.

Test of Conditional Random Assignments

The econometric model to test the conditional random assignments assumption takes the form:

$$\begin{aligned}\text{Prob}(\textit{Combat} = 1|\mathbf{M}, \mathbf{X}) &= F(\beta_0 + \beta_1' \mathbf{M} + \beta_2' \mathbf{X}) \\ \text{Prob}(\textit{Combat} = 0|\mathbf{M}, \mathbf{X}) &= 1 - F(\cdot)\end{aligned}\tag{3.1}$$

where *Combat* represents a location assignment variable. Wave IV interview responses permit creation of location assignment variables at two levels. *Combat Zone (CZ)* is a binary variable referring to assignment to a combat zone. A more refined variable, *Combat Exposure (CE)*, refers to deployment location assignments where a veteran (i) saw anyone wounded, killed, or dead (ii) engaged in at least one firefight, or (iii) killed or thought he killed someone. The military vector $\mathbf{M}$ includes service timing as well as an individual's branch, rank, occupation. Table 3.2 provides variable definitions and descriptive statistics for the measures of combat and vector $\mathbf{M}$.

Table 3.2 Description of Combat Experience and Military Control Measures

Variable	Description	Deployed Overseas (N=485)	Combat Zone (N=370)
Location Assignment			
<i>Combat Zone (CZ)</i>	Equal to 1 if respondent reported any positive amount of service time assigned to a combat zone, 0 otherwise	0.763 (0.43)	1.00 (0.00)
<i>Combat Exposure (CE)</i>	Equal to 1 if respondent reported deployment location assignment where he (i) saw anyone wounded, killed, or dead (ii) engaged in at least one firefight, or (iii) killed or thought he killed someone, otherwise equal to 0 only if not assigned to combat zone or assigned to combat zone and any combat exposure (i-iii) questions answered all did not indicate exposure. (N=484 for Deployed Overseas, N=369 for Combat Zone)	0.552 (0.50)	0.724 (0.45)
Military Controls			
<i>Rank E4</i>	Reference group is respondent attained enlisted rank E3 or less Equal to 1 if respondent attained enlisted rank E4, 0 otherwise	0.326 (0.47)	0.305 (0.46)
<i>E5</i>	Equal to 1 if respondent attained enlisted rank E5, 0 otherwise	0.375 (0.48)	0.392 (0.49)
<i>E6 and above</i>	Equal to 1 if respondent attained enlisted rank E6 or higher, 0 otherwise	0.169 (0.38)	0.195 (0.40)
<i>Officer</i>	Equal to 1 if respondent attained officer rank either W1 or O1 or higher, 0 otherwise	0.068 (0.25)	0.076 (0.26)
<i>Branch Army</i>	Service branch not mutually exclusive in sample Equal to 1 if respondent served in the Army, 0 otherwise	0.427 (0.50)	0.449 (0.50)
<i>Navy</i>	Equal to 1 if respondent served in the Navy, 0 otherwise	0.247 (0.43)	0.235 (0.42)
<i>Air Force</i>	Equal to 1 if respondent served in the Air Force, 0 otherwise	0.157 (0.36)	0.170 (0.38)
<i>Marine Corps</i>	Equal to 1 if respondent served in the Marine Corps, 0 otherwise	0.202 (0.40)	0.184 (0.39)
<i>Occupational Classification</i>	Standard 6-digit codes aggregated at intermediate level with exception of military specific occupations which are divided into more detailed categories. Reference Table A3.1 for individual definitions and descriptive statistics.		
<i>Timing Pre 9/11</i>	Equal to 1 if respondent entered military service prior to September 2001, 0 otherwise	0.808 (0.39)	0.792 (0.41)

Standard deviations in parentheses. Unweighted means generated using Wave IV of NLSAAH.

The vector **X** includes pre-deployment individual and family background variables that could be associated with combat assignment or an STD. These variables represent past sexual behavior, use of health services, health expectations, physical attributes, age, race, ethnicity, religion, cognitive ability, educational aspirations, biological mother's education, family

structure, and family resources determined from responses at the Wave I interview. Table 3.3 provides variable definitions and descriptive statistics for vector $\mathbf{X}$.

Table 3.3 Description of Individual and Family Background Measures

Variable	Description	Deployed Overseas (N=485)	Combat Zone (N=370)
Past sexual behavior	Reference group is no vaginal intercourse		
<i>Recent sex with birth control</i>	Equal to 1 if respondent used any method of birth control during most recent sexual intercourse, 0 otherwise	0.266 (0.44)	0.262 (0.44)
<i>Recent sex without birth control</i>	Equal to 1 if respondent did not use any method of birth control during most recent sexual intercourse, 0 otherwise	0.126 (0.33)	0.119 (0.32)
Past use of health services and health expectations			
<i>Did not seek medical care when needed</i>	Equal to 1 if respondent indicated any time over the past year when he thought he should get medical care but did not, 0 otherwise	0.227 (0.42)	0.227 (0.42)
<i>Physical exam more than 2 years ago</i>	Equal to 1 if time since respondent's last physical examination by a doctor or nurse was more than 2 years ago, 0 otherwise	0.062 (0.24)	0.054 (0.23)
<i>Expected Mortality</i>	Scale of respondent's expectation of living to age 35. (1=almost no chance, 5=almost certain)	4.369 (0.89)	4.392 (0.87)
Physical attributes			
<i>Height</i>	Values in inches displayed. Values standardized for regression estimations.	68.64 (3.85)	68.46 (3.83)
<i>Weight</i>	Values in pounds displayed. Values standardized for regression estimations.	146.80 (30.10)	145.00 (30.16)
Age			
<i>Age in years</i>	Values calculated based upon Wave I birth information and displayed for age at Wave IV interview. Values standardized for regression estimations.	28.73 (1.74)	28.61 (1.77)
<i>Age in years squared</i>	Value of age in years x age in years. Values standardized for regression estimations.	828.68 (99.46)	821.85 (100.58)
Race and Ethnicity	Respective reference groups are white and non-Hispanic		
<i>Race: Black</i>	Equal to 1 if respondent indicated black race, 0 otherwise	0.223 (0.42)	0.224 (0.42)
<i>Race: Other</i>	Equal to 1 if respondent indicated race other than white or black, 0 otherwise	0.074 (0.26)	0.084 (0.28)
<i>Ethnicity: Hispanic</i>	Equal to 1 if respondent indicated Hispanic or Latino origin, 0 otherwise	0.163 (0.37)	0.165 (0.37)
Religion	Reference group is no religion		
<i>Religion: Catholic</i>	Equal to 1 if respondent indicated Catholic religion, 0 otherwise	0.231 (0.42)	0.249 (0.43)
<i>Religion: Other Christian or Protestant</i>	Equal to 1 if respondent indicated other Christian or Protestant religion, 0 otherwise	0.612 (0.49)	0.595 (0.49)
<i>Religion: Other</i>	Equal to 1 if respondent indicated a religion other than Christianity, 0 otherwise	0.037 (0.19)	0.038 (0.19)
<i>Missing data: Religion</i>	Equal to 1 if missing information on religion, 0 otherwise	0.012 (0.11)	0.014 (0.12)
Cognitive Ability and Education			
<i>Picture Peabody Vocabulary Test score</i>	Score intended to estimate cognitive ability. Raw score displayed, values standardized for regression estimations.	103.58 (13.15)	103.60 (13.39)
<i>Missing data: Picture Peabody Vocabulary Test score</i>	Equal to 1 if missing Picture Peabody Vocabulary Test score, 0 otherwise	0.070 (0.26)	0.076 (0.26)
<i>College Aspirations</i>	Scale of respondent's college aspirations (1=low aspirations, 5=high aspirations)	4.472 (0.99)	4.516 (0.96)

Variable	Description	Deployed Overseas (N=485)	Combat Zone (N=370)
<i>College Attendance Expectation</i>	Scale of respondent's expectation of attending college (1=almost no chance, 5=almost certain)	4.052 (1.09)	4.081 (1.07)
<i>Mother's education</i>	Reference group is less than high school education		
<i>Mother's education: High school</i>	Equal to 1 if high school was highest level of biological mother's education, 0 otherwise	0.324 (0.47)	0.319 (0.47)
<i>Mother's education: Above high school</i>	Equal to 1 if biological mother completed at least some college education, 0 otherwise	0.450 (0.50)	0.449 (0.50)
<i>Missing data: Mother's education</i>	Equal to 1 if missing information on biological mother's education, 0 otherwise	0.103 (0.30)	0.114 (0.32)
<i>Family structure</i>	Reference groups are parents married and two or more siblings		
<i>Parents' marital status: Not married</i>	Equal to 1 if respondent's parents never married, divorced, separated, or widowed, 0 otherwise	0.227 (0.42)	0.238 (0.43)
<i>Missing data: Parents' marital status</i>	Equal to 1 if missing information on parents' marital status, 0 otherwise	0.140 (0.35)	0.132 (0.34)
<i>Siblings: None</i>	Equal to 1 if respondent has no siblings, 0 otherwise	0.031 (0.17)	0.027 (0.16)
<i>Siblings: One</i>	Equal to 1 if respondent has one sibling, 0 otherwise	0.208 (0.41)	0.214 (0.41)
<i>Parental resources</i>			
<i>Log of Parental income</i>	Natural logarithm of 1994 household pre-tax income reported by parent	3.594 (0.58)	3.608 (0.59)
<i>Missing data: Parental income</i>	Equal to 1 if missing information on parental income, 0 otherwise	0.256 (0.44)	0.249 (0.43)

Standard deviations in parentheses. Unweighted means generated using Wave I of NLSAAH.

The scalar β_0 represents the function intercept, the coefficient vector β_1' measures whether military observables explain location assignment, and the coefficient vector β_2' measures whether pre-deployment individual and family background variables explain location assignment. The $F(\cdot)$ is the function linking the probability with the covariates for an individual. If deployment location assignment is exogenous to an individual's STD diagnosis in a similar environment, then the coefficient vector β_1' should influence location assignment and the coefficient vector β_2' should not influence location assignment. As the model is non-linear, the effect of a given change in an independent variable on the probability of a positive outcome changes with the value of the independent variable and complicates coefficient interpretation. In order to make model interpretation more tangible, results display the estimated marginal effect of each independent variable on the probability of the dependent variable. The marginal effect for

each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean. Table 3.4 provides estimation results of the model comparing (1) deployed veterans assigned to a combat zone versus non-combat zone, (2) deployed veterans assigned to combat exposure versus no combat exposure, and (3) combat zone veterans assigned to combat exposure versus no combat exposure. The first four rows of Table 3.4 display Wald-tests on the joint significance of all military variables and the joint-significance of all civilian variables. The remaining rows of Table 3.4 display the marginal effects for individual civilian variables and Wald-tests on joint significance of related groups of civilian variables.

Table 3.4 Marginal Effects of Background Characteristics on Location Assignment Probabilities

	(1) <i>CZ=1</i> versus <i>CZ=0</i>	(2) <i>CE=1</i> versus <i>CE=0</i>	(3) <i>CZ=1 & CE=1</i> versus <i>CZ=1 & CE=0</i>
Wald-test all military controls (individual control estimates not displayed)	44.13	54.40	42.08
Wald-test all military controls <i>p</i> value	0.005	0.000	0.008
Wald-test all civilian variables (individual variable estimates displayed below)	21.34	24.85	34.70
Wald-test all civilian variables <i>p</i> value	0.846	0.686	0.215
Variable			
Past sexual behavior (reference group is no vaginal intercourse)			
<i>Recent sex with birth control</i>	0.029 (0.047)	0.068 (0.055)	0.067 (0.057)
<i>Recent sex without birth control</i>	0.033 (0.060)	0.075 (0.070)	0.031 (0.073)
Wald test on joint significance	0.512	1.996	1.360
Wald test <i>p</i> value	0.774	0.369	0.507
Past health services and health expectations			
<i>Reported not seeking medical care when needed</i>	0.008 (0.046)	0.016 (0.052)	0.048 (0.054)
<i>No physical exam in past 2 years</i>	-0.092 (0.072)	-0.046 (0.089)	0.011 (0.096)
<i>Estimated chance of living to age 35 (low to high scale 1 to 5)</i>	0.023 (0.021)	0.012 (0.024)	-0.014 (0.025)
Wald test on joint significance	2.813	0.616	1.008
Wald test <i>p</i> value	0.421	0.893	0.799
Physical attributes			
<i>Height – standardized</i>	0.016 (0.029)	0.009 (0.034)	-0.016 (0.036)
<i>Weight – standardized</i>	-0.027 (0.028)	-0.009 (0.034)	0.022 (0.037)
Wald test on joint significance	0.942	0.0939	0.387
Wald test <i>p</i> value	0.624	0.954	0.824
Age			
<i>Age in years – standardized</i>	0.277 (0.636)	0.357 (0.698)	0.299 (0.734)
<i>Age in years squared – standardized</i>	-0.326 (0.628)	-0.406 (0.692)	-0.314 (0.730)
Wald test on joint significance	4.542	3.543	0.494
Wald test <i>p</i> value	0.103	0.170	0.781
Race and ethnicity (respective reference groups are white and non-Hispanic)			
<i>Race: Black</i>	0.040 (0.055)	-0.041 (0.063)	-0.043 (0.061)
<i>Race: Other</i>	0.129 (0.087)	0.107 (0.088)	0.034 (0.086)
<i>Ethnicity: Hispanic</i>	-0.030 (0.059)	-0.159 (0.064)	-0.194 (0.063)
Wald test on joint significance	2.888	8.437	9.813
Wald test <i>p</i> value	0.409	0.0378	0.0202
Religion (reference group is no religion)			
<i>Religion: Catholic</i>	0.080 (0.070)	0.054 (0.081)	0.026 (0.085)
<i>Religion: Other Christian or Protestant</i>	0.017 (0.060)	-0.024 (0.072)	-0.047 (0.078)
<i>Religion: Other</i>	0.037 (0.110)	0.001 (0.128)	-0.058 (0.128)
Wald test on joint significance	2.228	1.904	2.162
Wald test <i>p</i> value	0.694	0.753	0.706

	(1)	(2)	(3)
Cognitive ability and education			
<i>Cognitive ability: Picture vocabulary test score – standardized</i>	-0.015	-0.014	0.002
	(0.026)	(0.028)	(0.028)
<i>Education: College Aspirations (low to high scale 1-5)</i>	0.015	0.004	-0.007
	(0.024)	(0.028)	(0.030)
<i>Education: College Attendance Expectation (low to high scale 1-5)</i>	-0.005	-0.005	-0.004
	(0.023)	(0.026)	(0.026)
Wald test on joint significance	1.907	3.322	6.732
Wald test <i>p</i> value	0.753	0.505	0.151
Mother's education (reference group is less than high school)			
<i>Mother's education: High school</i>	-0.068	-0.128	-0.112
	(0.064)	(0.075)	(0.076)
<i>Mother's education: Above high school</i>	-0.107	-0.028	0.061
	(0.068)	(0.079)	(0.084)
Wald test on joint significance	5.162	5.582	10.79
Wald test <i>p</i> value	0.160	0.134	0.0129
Family structure (reference groups are parents married and two or more siblings)			
<i>Parents' marital status: Never married, divorced, separated or widowed</i>	0.035	-0.041	-0.072
	(0.052)	(0.058)	(0.057)
<i>Siblings: None</i>	-0.057	-0.052	-0.098
	(0.098)	(0.125)	(0.132)
<i>Siblings: One</i>	0.003	0.036	0.062
	(0.047)	(0.054)	(0.055)
Wald test on joint significance	0.840	2.276	7.150
Wald test <i>p</i> value	0.933	0.685	0.128
Family resources			
<i>Family resources: Log of household income</i>	0.058	0.010	-0.022
	(0.038)	(0.044)	(0.045)
Wald test on joint significance	2.424	0.0734	0.257
Wald test <i>p</i> value	0.298	0.964	0.879
Observations	485	484	369
Pseudo-R²	0.15	0.14	0.20

CZ=Combat Zone, **CE**=Combat Exposure. Column 1 displays logistic regression marginal effects for CZ assignment for all overseas Active Duty veterans. Column 2 displays logistic regression marginal effects for CE assignment for all overseas Active Duty veterans. Column 3 displays logistic regression marginal effects for CE assignment for Active Duty veterans with CZ service. Standard errors in parentheses. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean. All columns include military control variables for branch, rank, occupation, and time of service entry determined from Wave IV interview responses. Civilian variables determined from Wave 1 interview responses. All columns include dummy variables for missing values of religion, picture vocabulary test score, mother's education, parents' marital status, and household income. Wald tests include dummy variables for respective missing values of religion, picture vocabulary test score, mother's education, parents' marital status, and household income.

The estimation results of the model provide support for the assumption of conditional random assignments using both location measures of combat. The marginal effects of military vector **M** are statistically significant with Wald tests on joint significance, and the marginal effects of the pre-deployment individual and family characteristics vector **X** are not statistically significant with Wald tests on joint significance. Of the 30 variables for individual and family

characteristics used in examining assignment to a combat zone, all marginal effects are statistically indistinguishable from zero at the 5 percent level. Additionally, separate tests on joint significance for relevant groups of variables (e.g. grouping past safe and unsafe sexual behavior) indicate groups are statistically indistinguishable from zero at the 5 percent level. The results are similar for assignments to a location with combat exposure. Of the 30 variables for individual and family characteristics used in estimations for the overseas sample and combat zone subsample, only the variable referring to Hispanic ethnicity is indistinguishable from zero at the 5 percent level. Joint tests on significance find only the group of variables representing race and ethnicity indicate a significant relationship with combat for both the deployed and combat zone samples. While the results are consistent with the expected Type I error rate, additional tests to validate the conditional random assignments are discussed following initial estimation of the relationship between combat experiences and STDs.

Effects of Combat Experiences on Acquiring an STD

Active Duty Overseas Sample

Incorporating the assumption of conditional random assignments into the conceptual framework's equation 2.3, the conditional effect of combat experiences on acquiring an STD can be estimated with the equation:

$$\begin{aligned}\text{Prob}(\text{Disease} = 1 | \text{Combat}, \mathbf{M}, \mathbf{X}) &= F(\delta_0 + \delta_1 \text{Combat} + \pi_1' \mathbf{M} + \pi_2' \mathbf{X}) \\ \text{Prob}(\text{Disease} = 0 | \text{Combat}, \mathbf{M}, \mathbf{X}) &= 1 - F(\cdot)\end{aligned}\tag{3.2}$$

where *Disease* represents one of the previously described measures of STDs and *Combat* represents one of the location assignment variables. $F(\cdot)$ is the function linking the probability of an STD with the covariates for an individual. The scalar δ_0 is the function intercept. The key parameter of interest, δ_1 , shows how a combat experience is associated with the probability of

acquiring an STD. The vectors $\mathbf{M}$ and $\mathbf{X}$ are as previously described, and coefficient vectors π_1' and π_2' explain how the variables in $\mathbf{M}$ and $\mathbf{X}$ relate to an STD. The validity of the exogeneity assumption can be further assessed by estimating equation 3.2 without vector $\mathbf{X}$. If the exogeneity assumption is valid, then δ_1 should be stable.

Next, estimations address heterogeneity in the effect of deployed combat experiences. As policies accompany combat zone assignment independent of both deployed service status and combat exposure that may also influence sexual behavior, it is important to assess the role of combat service independently from combat exposure. The addition of a separate variable, *CNE* delineating combat zone service without exposure, in equations 3.2 captures combat zone factors independent of deployed service and combat exposure. The expanded equation 3.2 takes the form:

$$\begin{aligned}\text{Prob}(\text{Disease} = 1 | CE, CNE, \mathbf{M}, \mathbf{X}) &= F(\delta_0 + \delta_1 CE + \delta_2 CNE + \pi_1' \mathbf{M} + \pi_2' \mathbf{X}) \\ \text{Prob}(\text{Disease} = 0 | CE, CNE, \mathbf{M}, \mathbf{X}) &= 1 - F(\cdot)\end{aligned}\tag{3.3}$$

where the parameter, δ_1 , captures the combined effect of combat zone service factors (e.g. ban on sexual relations between unmarried individuals) and combat exposure for the deployed population. The parameter, δ_2 , shows how combat zone service factors, independent of overseas deployed service factors and combat exposure, are associated with the probability of acquiring an STD. The difference, $\delta_1 - \delta_2$, represents the effect of combat exposure on those with combat zone service.

Active Duty Combat Zone Sample

Variation in combat deployment length and combat harm is also critical in explaining the relationship of combat exposure with acquiring an STD. Only respondents reporting assignment to a combat zone were asked about deployment length and wounds or injuries, and estimations

limited to the combat zone sample decompose the intertwined relationships of these factors and combat exposure with an STD. Equation 3.4 incorporates combat deployment length and takes the following form:

$$\begin{aligned}\text{Prob}(\text{Disease} = 1|CE, L, \mathbf{M}, \mathbf{X}) &= F(\gamma_0 + \gamma_1 CE + \gamma_2 L + \omega_1' \mathbf{M} + \omega_2' \mathbf{X}) \\ \text{Prob}(\text{Disease} = 0|CE, L, \mathbf{M}, \mathbf{X}) &= 1 - F(\cdot)\end{aligned}\tag{3.4}$$

where CE refers to combat exposure and L refers to all veterans spending 16 or more months assigned to a combat zone. As the maximum standard deployment length prior to the Wave IV interview did not exceed 15 months, the variable L also captures many of those who experienced repeated combat zone deployments. $F(\cdot)$ is the function linking the probability of an STD with the covariates for an individual. The scalar γ_0 is the function intercept. The key parameter of interest, γ_1 , captures the effect of combat exposure on an STD independent of deployment length, while parameter, γ_2 , captures the effect of longer deployed time on an STD. Coefficient vectors ω_1' and ω_2' explain how vectors $\mathbf{M}$ and $\mathbf{X}$ relate to an STD.

As veterans with wounds or injuries more often report witnessing others wounded or dead, engaging in a firefight, or thinking they killed someone than veterans without wounds or injuries, the effect of wounds or injuries may be responsible for any observed effect of combat exposure. Equation 3.5 incorporates combat exposure and combat harm variables:

$$\begin{aligned}\text{Prob}(\text{Disease} = 1|CENW, L, W, \mathbf{M}, \mathbf{X}) &= F(\gamma_0 + \gamma_1 CENW + \gamma_2 L + \gamma_3 W + \pi_1' \mathbf{M} + \pi_2' \mathbf{X}) \\ \text{Prob}(\text{Disease} = 0|CENW, L, W, \mathbf{M}, \mathbf{X}) &= 1 - F(\cdot)\end{aligned}\tag{3.5}$$

where the variable $CENW$ refers to those who do not report wounds or injuries, but do report one of the three previously described combat exposure criteria. The variable W refers to those reporting wounds or injuries. The parameter γ_1 captures the effect of combat exposure, independent of reported harm and deployment length, on an STD. The parameter γ_3 captures the

effect of being wounded or injured on an STD. The remainder of the equation mirrors equation 3.4.

Generalized Maximum Entropy Estimation

Uncertainty surrounding small samples, infrequently observed outcomes, and highly correlated covariates motivates GME multinomial estimation of the relationship between combat experiences and veteran well-being. The GME multinomial estimator is an extension of the information-theoretic Maximum Entropy (ME) multinomial estimator (Golan, Judge, and Perloff 1996; Golan, Judge, and Miller 1996). Information theoretic approaches seek to estimate relationships in observable data without imposing assumptions inconsistent with true data generating processes. The ME principle dictates probability distributions should be as uniform as possible, or have maximum entropy, when nothing is known (Jaynes 1957). The ME principle can be used in an info-metric optimization framework to tackle problems where there is not enough information to find a unique solution; ME multinomial estimates are inferred by optimizing an entropy based objective function with moment constraints based on observed data (Denzau, Gibbons, and Greenberg 1989; Soofi 1992; Golan, Judge, and Perloff 1996; Golan, Judge, and Miller 1996). The ME multinomial estimator is mathematically equivalent to the traditional Maximum Likelihood (ML) logit estimator, and traditional likelihood based inference tests are applicable to ME multinomial estimates. Like the ML logit estimator, the ME multinomial estimator restricts the expected error value to zero. The GME approach, recognizing uncertainty surrounding observed moments, uses stochastic moment constraints (Golan, Judge, and Perloff 1996; Golan, Judge, and Miller 1996). Error support space for each multinomial alternative is set within natural bounds, *i.e.* the $[-1, 1]$ interval. GME estimates are then inferred by jointly maximizing entropies of the signal and (normalized) error subject to stochastic

moment constraints. The flexibility added by the generalized approach accommodates uncertainty surrounding small samples, infrequently observed outcomes, and highly correlated covariates; the GME multinomial estimator, in all finite samples, outperforms ML and ME alternatives in terms of efficiency and robustness. Additionally, GME multinomial estimates, when all errors are zero or as the sample size approaches infinity, are equivalent to ML logit and ME estimates. Chapter 3 GME estimations are performed with Stata 13 software (Corral and Terbish 2015). For an in-depth discussion of info-metric foundations and applications, see Golan (2018).

Estimates of the Effects of Combat Experiences on an STD

Table 3.5 provides estimated marginal effects from $\hat{\delta}_1$ and $\hat{\delta}_2$ with the Active Duty overseas sample, while Table 3.6 provides estimated marginal effects from $\hat{\gamma}_1$, $\hat{\gamma}_2$, and $\hat{\gamma}_3$ with the Active Duty combat zone sample. Table 3.7 examines the robustness of combat exposure estimates for veterans responding to the Wave III interview.

Active Duty Overseas Sample

Table 3.5 presents findings on the relationship between combat experiences and an STD for the full Active Duty overseas sample. The dependent variable for columns 1 and 2 represents whether a veteran has received an STD diagnosis since the Wave I interview, while the dependent variable for columns 3 and 4 represents whether a veteran has received an STD diagnosis in the year prior to the Wave IV interview. Estimates in columns 1 and 3 are conditional on military observables, while estimates in columns 2 and 4 also include individual and family background characteristics. Panels for different combat experiences divide the table horizontally, and brackets contain the number of observations for each estimation.

Table 3.5 Panel A presents the estimated marginal effect of a combat zone assignment for deployed Active Duty veterans as described in equation 3.2. The estimates across outcome measures indicate the effect of assignment to a combat zone on an STD is not significantly different from zero for deployed Active Duty veterans, and the estimates of combat zone assignment are in line with the previous study of the relationship between combat deployment and risky sex (Thomsen et al. 2011).

Table 3.5 Panel B presents estimated marginal effect of combat exposure for deployed Active Duty veterans as described in equation 3.2. For the estimation including military and civilian controls, assignment overseas with combat exposure relative to assignment overseas without combat exposure is associated with a 7.9 percentage point increase in acquiring an STD since the Wave I interview. Point estimates for the effect of combat exposure on a past year STD are also positive and represent values of economic significance, but estimates are not precise. Thus, caution must be exercised when interpreting the results outside of the given sample.

Table 3.5 Panel C examines heterogeneity in marginal effects of deployed combat experiences for deployed Active Duty veterans as described in equation 3.3. Columns 1 and 2 show combat zone service, independent of combat exposure, is associated with a decreased probability of an STD since the Wave I interview. The drop in the magnitude and significance of parallel estimates in columns 3 and 4 suggests any influence of combat zone service, independent of combat exposure, on an STD may be short lived. In contrast, Wald tests across all columns on the difference in effects suggest the effect of combat exposure on an STD for those within a combat zone is statistically different from zero and potentially longer lasting. For estimation including military and civilian controls, results indicate combat zone assignment with combat exposure relative to combat zone assignment without combat exposure is associated with

a 12.6 percentage point increase in an STD since the Wave I interview and a 5.4 percentage point increase in a past year STD. The point estimates, about the same size as dependent variables means in Table 3.1, suggest combat exposure has a potentially large influence on STD acquisition.

The inclusion of civilian controls in Table 3.5 has little influence on the magnitude of findings. An informal gauge of the strength of likely bias from unobservables can be calculated by dividing the marginal effect from the full equation by its difference with the marginal effect from the equation without the $\mathbf{X}$ vector (Altonji, Elder, and Taber 2005). The calculation shows informally how much stronger the selection on unobservables, relative to the selection on civilian controls, would need to be to explain the full magnitude of the estimated effect. Given point estimates for the effect of combat exposure in Panel B and effect of combat exposure in a combat zone in Panel C, the median magnitude of the four ratios is 5.3, with a minimum magnitude of 4.5. The ratios imply selection on unobservables would need to be more than four times greater than selection on civilian control variables, including previous sexual behavior, to explain away the estimated effect. Additionally, though estimations of Equation 3.1 suggested race and ethnicity could potentially influence a combat location assignment, unreported estimates from a non-white Hispanic subsample are consistent with the estimates from the full sample. As much as patterns in unobservable characteristics follow patterns in observable characteristics, the set of results further supports the assumption of conditionally random location assignments.

Table 3.5 Marginal Effects of Deployment Assignments on an STD

Variables	(1) STD	(2) STD	(3) Past year STD	(4) Past year STD
Panel A: Effect of combat zone assignment				
<i>Combat Zone</i>	-0.017 (0.040)	-0.019 (0.040)	-0.003 (0.027)	-0.000 (0.027)
Civilian Controls?	No	Yes	No	Yes
Observations	[485]	[485]	[485]	[485]
Pseudo-R ²	0.46	0.51	0.72	0.75
Panel B: Effect of combat exposure assignment				
<i>Combat Exposure</i>	0.062 (0.034)	0.079 (0.033)	0.028 (0.024)	0.036 (0.024)
Civilian Controls?	No	Yes	No	Yes
Observations	[484]	[484]	[484]	[484]
Pseudo-R ²	0.46	0.52	0.72	0.75
Panel C: Difference in effect of combat zone assignment				
<i>Combat Zone - Exposure</i>	0.013 (0.039)	0.021 (0.039)	0.010 (0.027)	0.016 (0.027)
<i>Combat Zone - No Exposure</i>	-0.092 (0.037)	-0.105 (0.035)	-0.036 (0.025)	-0.038 (0.025)
Difference in effects	0.105	0.126	0.046	0.054
Standard error based on Wald test*	(0.037)	(0.036)	(0.026)	(0.026)
Civilian Controls?	No	Yes	No	Yes
Observations	[484]	[484]	[484]	[484]
Pseudo-R ²	0.47	0.53	0.72	0.75

Marginal effects from GME multinomial regressions displayed for Active Duty overseas veterans. Standard errors in parentheses. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean. Military control variables listed in Table 3.2 included in all regressions. Civilian control variables listed in Table 3.3 for column 2 and 4 regressions. All estimations include post-deployment binary variables for health insurance status and physical exam in past two years. Number of observations in brackets. *Non-linear Wald test of (Marginal effect of *Combat Zone Exposure* - Marginal Effect of *Combat Zone No Exposure*) = 0

Active Duty Combat Zone Sample

Table 3.6 presents findings on the relationship between combat deployment experiences and an STD that account for the time spent in a combat zone and wounds or injuries. The dependent variable for columns 1 and 2 represents whether a veteran has received an STD diagnosis since the Wave I interview, while the dependent variable for columns 3 and 4 represents whether a veteran has received an STD diagnosis in the year prior to the Wave IV interview. Estimates in columns 1 and 3 are conditional on military observables, while estimates in columns 2 and 4 also include individual and family background characteristics.

Table 3.6 Panel A provides estimates of equation 3.4. The results indicate combat exposure is associated with increases in the probability of both measures of an STD, while also providing some evidence long amounts of time spent in a combat zone (and under the prohibition of many risky health behaviors) produce the opposite effect. For estimation including military and civilian controls, combat zone assignment with combat exposure relative to combat zone assignment without combat exposure is associated with a 17.0 percentage point increase in an STD since the Wave I interview. Point estimates for the effect of combat exposure on a past year STD are also positive and represent values of economic significance, but estimates are only significant at 10 percent and require caution in interpretation. For estimation including military and civilian controls, combat zone assignment of 16 months or longer relative to a shorter combat zone assignment is associated at the 10 percent significance level with a 6.5 percentage point decrease in an STD since the Wave I interview. The point estimates for the effect of combat zone assignment of 16 months or longer on a past year STD are also positive, but relatively smaller and insignificant. Similar to Table 3.5 Panel C, the results suggest any influence of other combat zone factors on an STD may be short lived. As veterans could potentially become more or less resilient during extended combat zone service, a model including an interaction term between combat exposure and combat zone time in Equation 3.4 was also estimated. The unreported estimated parameter for the interaction term was not significant, which suggests any combat exposure effect is independent of time spent in a combat zone. Additionally, unreported estimations of models including interactions of combat exposure with time of service entry, past sexual behavior, and marital status (measured only at Wave IV) suggest the relationship of combat exposure with STDs does not vary across groups of male veterans.

Table 3.6 Panel B controls for combat deployed time and being wounded or injured as described in equation 3.5. Panel B provides further evidence suggesting combat exposure, independent of physical harm, is associated with increases in the probability of an STD. The results show both combat exposure without wounds or injuries is associated with an increased probability of an STD since the Wave I interview. While the marginal effects of wounds or injuries on the probability of a diagnosed STD in the past year are not precise, the relatively large standard errors suggest the actual effect size may be non-zero.

Similar to the estimates of combat exposure in Table 3.5, the inclusion of civilian controls in Table 3.6 has little influence on the magnitude of estimates. The results provide further evidence in support of the assumption of conditional random location assignments.

Table 3.6 Marginal Effects of Deployment Related Variables on an STD

Variables	(1) STD	(2) STD	(3) Past year STD	(4) Past year STD
Panel A: Combat exposure and deployed time effects				
<i>Combat exposure</i>	0.142 (0.045)	0.170 (0.044)	0.061 (0.036)	0.069 (0.036)
<i>Combat zone time >= 16 months</i>	-0.082 (0.035)	-0.065 (0.037)	-0.040 (0.024)	-0.033 (0.026)
Civilian Controls?	No	Yes	No	Yes
Observations	[369]	[369]	[369]	[369]
Pseudo-R ²	0.52	0.59	0.72	0.76
Panel B: Combat exposure, harm, and deployed time effects				
<i>Combat Exposure - Not Wounded</i>	0.136 (0.047)	0.150 (0.045)	0.060 (0.036)	0.073 (0.037)
<i>Wounded or injured</i>	0.124 (0.065)	0.164 (0.064)	0.037 (0.050)	0.023 (0.052)
<i>Combat zone time >= 16 months</i>	-0.079 (0.035)	-0.060 (0.037)	-0.038 (0.024)	-0.028 (0.026)
Civilian Controls?	No	Yes	No	Yes
Observations	[368]	[368]	[368]	[368]
Pseudo-R ²	0.51	0.58	0.72	0.77

Marginal effects from GME multinomial regressions displayed for Active Duty combat zone veterans. Standard errors in parentheses. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean. Military control variables listed in Table 3.2 included in all regressions. Civilian control variables listed in Table 3.3 for column 2 and 4 regressions. All estimations include post-deployment binary variables for health insurance status and physical exam in past two years. Number of observations in brackets.

Additional Robustness Checks

Results thus far find combat exposure consistently associated with an increased probability of an STD, though the roughly 13 years between the Wave I and Wave IV interview make conclusions about changes resulting from combat exposure challenging without additional evidence. The measure of an STD since the Wave I interview may capture an STD prior to deployment, and the measure of a past year STD may reflect behavioral patterns developing prior to deployment. Though the sample lacks information on deployment start times, the August 2001-April 2001 Wave III in-home visit occurred prior to the bulk of recent combat operations and included survey questions on recent STD diagnoses as well as laboratory tests for gonorrhea, chlamydial infection, and trichomoniasis. The information permits estimations to control for previous STDs at more mature sexual ages for the sub-sample continuing or starting military

service in September 2001 or later. For the combat zone sub-sample, 8.3 percent at Wave III either report an STD diagnosis in the past year or test positive for gonorrhea, chlamydial infection, and trichomoniasis. Table 3.7 presents estimates of combat exposure on a Wave IV STD for individuals not indicating a Wave III STD using equation 3.4. Though the sample includes fewer than half of respondents from previous estimations and is more conducive to null results, estimated effects of combat exposure on an STD are all positive and significant. The results are testament to the strength of the relationship, and the results help address potential pre-deployment and post-deployment confounding concerns. Taken together, the findings in Tables 3.5-3.7 provide consistent evidence combat exposure is associated with an increased probability of an STD.

Table 3.7 Marginal Effects of Combat Exposure on an STD

Variables	(1) STD	(2) STD	(3) Past year STD	(4) Past year STD
<i>Combat exposure</i>	0.150 (0.033)	0.171 (0.034)	0.058 (0.027)	0.063 (0.034)
<i>Combat zone time >= 16 months</i>	-0.049 (0.044)	0.017 (0.060)	-0.051 (0.031)	-0.002 (0.042)
Civilian Controls?	No	Yes	No	Yes
Observations	[180]	[180]	[180]	[180]
Pseudo-R ²	0.58	0.64	0.74	0.80

Marginal effects from GME multinomial regressions displayed for post 2001 Active Duty combat zone veterans responding to Wave III. Standard errors in parentheses. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean. All STD measures reflect only Wave IV STDs for individuals not indicating any Wave III STD. Military control variables listed in Table 3.2 included in all regressions. Civilian control variables listed in Table 3.3 for column 2 and 4 regressions. All estimations include post-deployment binary variables for health insurance status and physical exam in past two years. Number of observations in brackets.

Exploration of Potential Mechanisms

Mental health, substance use, and the number of sexual partners may influence the production of STDs following combat exposure, but the establishment of a mechanism, or a pathway from combat exposure to an STD, requires several conditions (Baron and Kenny 1986). Assuming combat exposure affects acquiring an STD, combat exposure must first be shown to affect a mechanism. Second, a mechanism must be shown to affect an STD, independent of combat exposure. Finally, the effect of combat exposure on an STD must differ when a mechanism is included in the analysis. Analysis views establishment of the first two conditions sufficient for exploration, and decomposition of direct and indirect effects of combat exposure on an STD is not practical for the available sample size (MacKinnon 2008; Vittinghoff, Sen, and McCulloch 2009). Additionally, the temporal sequence of potential mechanisms and STDs following combat is not observable in the data. Thus, the end goal of exploration is to determine only whether the effect of a potential mechanism is significantly different from zero when included in the right hand side of equation 3.2.

Table 3.8 first presents estimates of how combat exposure affects potential mechanisms. Outcome measures capture variation in mental health, substance use, and sexual activity at the Wave IV interview. The binary measure, *PTSD*, in column 1 represents whether a veteran has ever received a PTSD diagnosis and engaged in sexual activity in the past year. The binary measure, *Substance use*, represents whether a veteran reported (i) usually having five or more alcoholic drinks at a time and drinking alcohol in the past 30 days, or using an illicit drug in the past 30 days and (ii) engaging in sexual activity in the past year. Lastly, the measure, *Number of Sexual Partners*, represents the number of male and female sexual partners reported in the past year.

Table 3.8 columns 1 to 2 present evidence on how combat exposure adversely affects mental health and substance use as previously established by research with the NLSAHH (Cesur, Sabia, and Tekin 2013; Cesur, Chesney, and Sabia 2016), and column 3 presents new evidence showing combat exposure is associated with an increase in the number of recent sexual partners. Estimates use potential mechanisms as the dependent variable and are conditional on military and civilian background characteristics in Tables 3.2-3.3. The key measure, the difference in the effects of combat experiences, represents the effect of combat exposure on those with combat zone service. GME multinomial regressions provide estimates in columns 1 and 2, while a Poisson regression with robust standard errors provides estimates in column 3. Estimations rely upon the 477 veterans in the Active Duty overseas sample who provide non-missing information on all outcomes.

Table 3.8 Marginal Effects of Combat Exposure on Possible Mechanisms

Variables	(1) PTSD	(2) Substance Use	(3) Number of Sexual Partners
<i>Combat Zone – Exposure</i>	0.190 (0.056)	0.132 (0.054)	0.152 (0.119)
<i>Combat Zone - No Exposure</i>	0.020 (0.084)	0.031 (0.068)	-0.111 (0.133)
Difference in estimates	0.170	0.101	0.263
Standard error based on Wald test*	(0.063)	(0.057)	(0.113)
Civilian Controls?	Yes	Yes	Yes
Observations	[477]	[477]	[477]
Pseudo-R ²	0.66	0.20	0.13

Marginal effects from GME multinomial regressions displayed for Columns 1 to 2. Estimates from Poisson regression with robust standard errors displayed for Column 3. Standard errors in parentheses. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean. All columns use Active Duty overseas sample. Dependent variables measured at Wave IV. Military control variables listed in Table 3.2 and civilian control variables listed in Table 3.3 included in all regressions. All estimations include post-deployment binary variables for health insurance status and physical exam in past two years. Number of observations in brackets. *Non-linear Wald test of (Marginal effect of *Combat Zone Exposure* – Marginal Effect of *Combat Zone No Exposure*) = 0

Table 3.9 presents estimates from the introduction of potential mechanisms on the right hand side of equation 3.2. Panel A shows the effect of combat exposure for veterans in a combat zone on an STD, while Panel B shows the influence of potential mechanisms on an STD. Column 1 includes no potential mechanisms. The results indicate assignment to combat zone with exposure relative to a combat zone without exposure is associated with a 5.2 percentage point increase in past year STD for the sample.

The estimate for the influence of PTSD on an STD in column 2 is not significantly different from zero, and the estimate does not support the hypothesis of poor mental health being a pathway to an STD. Post-Traumatic Growth, which research has found to occur more frequently among veterans with PTSD (Tsai et al. 2015), is one possible explanation for the empirical estimate. Social withdrawal accompanying PTSD could also reduce opportunities to acquire an STD. Finally, the observed results may be a function of the limited sample size and available measures of mental health.

The point estimate for the influence of substance use on an STD in column 3 is in line with substance use mediating the relationship between combat exposure and a past year STD. Alcohol and illegal drugs can affect a veteran's judgement and self-control, and veterans may increase risky sexual behaviors and acquire an STD. Still, the estimate is only significant at the 10 percent level and requires caution in interpretation.

Column 4 indicates veterans with higher numbers of sexual partners in the past year are more likely to report an STD. The model includes the *Number of Sexual Partners* and its square to capture a non-linear relation between sexual partners and STD, where veterans with higher numbers of sexual partners may be more vigilant in the use of contraceptives. The results suggest the number of sexual partners may mediate the relationship between combat exposure and a past year STD. A higher number of sexual partners could stem from either an inability to maintain relationships or an ability to establish multiple relationships. While investigation of combat exposure on marital and romantic relationship statuses did not reveal a link in the available sample, other research finds some evidence recent veterans following combat exposure are more likely to be divorced or separated (Edwards 2015), participate in intimate partner or child abuse, report increased relationship stress, report increased heated arguments, or threaten break-up (Cesur and Sabia 2016).

Table 3.9 Exploring Mechanisms through which Combat Exposure Affects a Past Year STD

Variables	(1)	(2)	(3)	(4)
Panel A: Effects of combat experiences				
<i>Combat Zone – Exposure</i>	0.011 (0.027)	0.013 (0.029)	0.007 (0.028)	0.014 (0.028)
<i>Combat Zone - No Exposure</i>	-0.041 (0.025)	-0.041 (0.025)	-0.042 (0.025)	-0.040 (0.026)
Difference in effects	0.052	0.054	0.049	0.054
Standard error from Wald test*	(0.026)	(0.026)	(0.026)	(0.025)
Panel B: Influence of potential mechanisms				
<i>PTSD</i>		-0.008 (0.038)		
<i>Substance Use</i>			0.038 (0.023)	
<i>Number of Sexual Partners</i>				0.023 (0.011)
<i>Number of Sexual Partners²</i>				-0.001 (0.001)
Civilian Controls?	Yes	Yes	Yes	Yes
Observations	[477]	[477]	[477]	[477]
Pseudo-R ²	0.75	0.75	0.75	0.75

Marginal effects from GME multinomial regressions displayed for Active Duty overseas veterans. Standard errors in parentheses. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean. Military control variables listed in Table 3.2 and civilian control variables listed in Table 3.3 included in all regressions. Number of observations in brackets. *Non-linear Wald test of (Marginal effect of *Combat Zone Exposure* – Marginal Effect of *Combat Zone No Exposure*) = 0

Summary of Results and Discussion

As this examination is the first effort (to the best of the author's knowledge) to examine the relationship between combat experiences and STDs among deployed veterans, the results cannot be directly compared to the findings of other studies. The results consistently support the hypothesis that combat exposure is associated with adverse consequences to the sexual health of deployed veterans. Additionally, the results indicate substance use and the number of recent sexual partners, a proxy for unstable relationships, are potential pathways to an STD following combat exposure and highlight possible triggers for STD screening.

I provide perspective on the economic significance of the main finding by translating the most precisely estimated marginal effect, a 5.4 percentage point increase, of combat exposure on a past year STD into direct medical costs. I assume the male veteran population has the same

transmission patterns and average estimated lifetime medical cost estimates as male Americans aged 15-24 contracting a new STD in the year 2000 (Chesson et al. 2004). I obtain an average \$759 per case cost for STDs included in the NLSAAH data. If the 2.7 million US troops deployed since 2001 experience a similar level of combat exposure to the 55 percent of deployed veterans reporting combat exposure in the NLSAAH health sample, then \$61 million represents a crude estimate of direct medical costs for STDs resulting from combat exposure in recent overseas operations. Moreover, the crude cost estimate includes neither direct non-medical costs such as cost of transportation to medical treatment nor indirect costs such as reduced productivity, lost wages, or disease transmission to other members of society. If interested in maximizing social welfare, policy makers must recognize the potential adverse influence of combat exposure on the domain of sexual health.

CHAPTER 4

COMBAT AND FINANCIAL PROBLEMS

The analysis of combat experiences with STDs provides insight into health consequences, and this chapter seeks to uncover functional economic consequences following combat experiences by looking at the production of financial problems. This chapter first discusses the data, then, it presents the estimation strategy and findings. It concludes with a discussion of the results.

Data: Millennium Cohort Study and Defense Manpower Data Center

The Millennium Cohort Study (MCS) was designed to evaluate the health effect of military exposures, and it is the largest prospective study ever undertaken in the US military. The study enrolled US military personnel from all service branches and Active Duty, Reserve, and National Guard components, and the study continues to follow participants after separation from the military. Questionnaires include over 450 measures for health, military experiences, and other militarily relevant issues. Participants complete questionnaires via secure website or mail at approximately three-year intervals (termed ‘waves’) for up to 21-years while in service and post service. Figure 4.1 displays the study timeline.

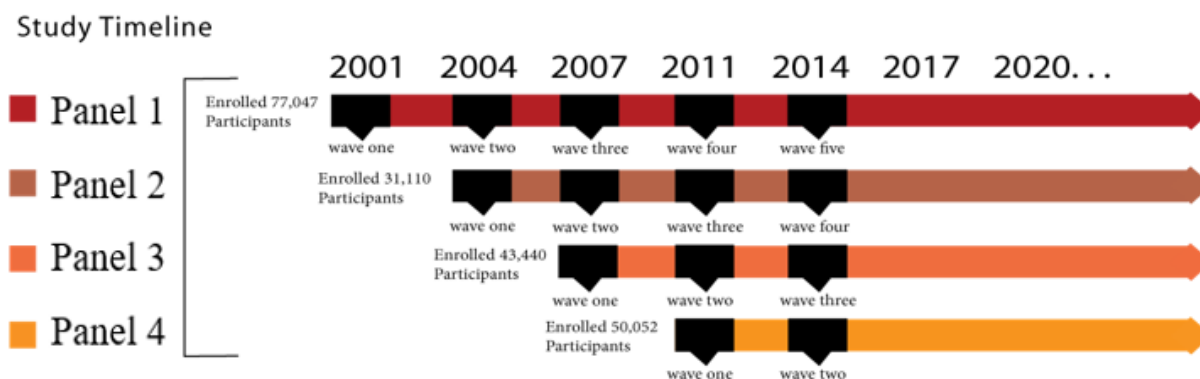


Figure 4.1 Millennium Cohort Study Timeline

The MCS consists of four panels of veterans. Participants complete questionnaires via secure website or mail at approximately three-year intervals (termed ‘waves’) for up to 21-years while in service and post service.

The MCS currently has 201,619 participants who enrolled during four separate panels between 2001 and 2013. Panel 1 (July 2001-June 2003) enrolled 77,047 consenting participants drawn from a population based sample of the October 2000 US military, with oversampling of females, those with previous deployment experience, and Reserve/Guard personnel. Panel 1 received 5 waves of questionnaires prior to 2016. Panels 2 and 3 sampled service members with 1-3 years of military service and oversampled females and Marines. Panel 2 (June 2004-February 2006) enrolled 31,110 participants, and Panel 3 (June 2007-December 2008) enrolled 43,439 participants. Panel 2 received 4 waves of questionnaires prior to 2016, and Panel 3 received 3 waves of questionnaires prior to 2016. Panel 4 sampled service members with 2-5 years of military service and oversampled females and married service members. Panel 4 (April 2011-April 2013) enrolled 50,052 participants. Panel 4 received 2 waves of questionnaires prior to 2016. Over 70 percent of all participants completed at least one follow-up questionnaire.

Questionnaires are only one part of the MCS data collection. The MCS links questionnaires with electronically maintained military datasets, including Defense Manpower Data Center (DMDC) information on deployments in support of the Global War on Terror. The military datasets provide information to supplement and validate many questionnaire items (see pp 55-77 of Amara and Hendricks 2013 for details on the MCS design and integration with military records). Multiple investigations of the MCS have found it to contain reliable data reporting with minimal non-response bias (Chretien et al. 2007; LeardMann et al. 2007; Riddle et al. 2007; Ryan et al. 2007; T. C. Smith, Zamorski, et al. 2007; B. Smith, Leard, et al. 2007; T. C. Smith, Jacobson, et al. 2007; B. Smith, Wingard, et al. 2007; Wells et al. 2008). The

comprehensive nature of the MCS data makes it well suited for this dissertation, and the longitudinal nature enables evaluation of temporal sequences from combat to different outcomes.

The available data are conditioned to represent only veterans likely eligible to experience combat and the onset of a financial problem. To capture veterans likely eligible to experience combat, sample observations include only those from 80,982 veterans with Global War on Terror deployments in 2001 or later, a basic military entry date and information to determine a veteran's military component at the baseline survey, and non-missing information on self-reported traumatic exposure at baseline and at least one follow-up. To capture the onset of financial problems, sample observations are further restricted to those from 64,654 veterans not reporting the highest level of financial distress or a major financial problem in the prior period. The sample also excludes observations from 146 veterans with missing or invalid information for age, gender, race or education. Overall, the 131,036 sample observations for analysis come from 64,508 veterans, including 27,635 Panel 1 veterans, 10,694 Panel 2 veterans, 13,698 Panel 3 veterans, and 12,481 Panel 4 veterans.

Financial Problems Measure

Four mutually exclusive states of financial decline are defined using survey responses on two items assessing financial problems from two consecutive waves. One survey item asks veterans to indicate one of three levels of stress concerning financial problems in the past 4 weeks, while the other survey item asks veterans to indicate whether they have suffered a major financial problem (such as bankruptcy) in the past 3 years. Table 4.1 describes the distribution of financial decline at each follow-up survey wave with the sample size shown in the last row. Approximately three-fourths of observations fall into the state, *None*, which represents reporting neither increasing stress about finances nor a new major financial problem since the prior survey

wave. The three other states capture different financial declines since the prior survey wave. The *Distress Only* state captures veterans reporting only increased financial stress in the four weeks prior to the follow-up survey. The state is likely to capture financial decline in response to combat experiences; however, the increase in financial distress may only reflect an expected increase in financial problems or a new minor financial problem. Approximately one in five veterans at each wave report only increased financial distress. The *Major Problem Only* state captures veterans reporting only an increase in past major financial problems in the past 3 years. The state may capture a major financial decline following a combat experience, but the information in the state alone is insufficient to determine whether the financial decline started prior to combat experiences. A little more than one percent of veterans at each wave report a major problem only. The state, *Major Problem & Distress*, captures new major financial problems (such as bankruptcy) with an increased level of financial distress, and about two percent of veterans at each wave report the combined transition. The state is of principal interest because it captures a large financial decline developing in response to combat experiences. The states are nominal, rather than ordered, because the expected relationship between each pair of states is unknown.

The financial decline variable, capturing increases in financial problems, is well suited overall to understand a veteran's response to combat experiences. The financial decline variable makes use of information from all available survey questions on financial problems. Although the variable does not assess the prevalence of different types of financial problems like bankruptcy and foreclosure, it leverages the sequential structure of the data to capture individual, rather than average, changes in financial problems. Considering the production of financial

problems as a transition from one state of economic well-being to another, one can also view the financial decline variable as capturing a first-order Markov process for economic well-being.

Table 4.1 Distribution of Financial Decline, by Survey Wave

State	Definition	Wave 2	Wave 3	Wave 4	Wave 5	Total
<i>None</i>	No new distress or major problem	75.41	75.49	73.6	77.34	75.34
<i>Distress Only</i>	Stress level (none, a little, or a lot) in the last 4 weeks from financial problems reported at current survey > stress level in the last 4 weeks from financial problems reported at prior survey. Did not also report new major problem.	21.23	21.17	22.03	19.67	21.17
<i>Major Problem Only</i>	Major financial problems (such as bankruptcy) in the past 3 years reported at current survey and not previous survey. Did not also report higher distress.	1.32	1.25	1.68	1.32	1.37
<i>Major Problem & Distress</i>	Reported new major problem and higher distress.	2.04	2.09	2.69	1.67	2.13
Observations		55,819	34,291	24,428	16,498	131,036

Source: 2001-2016 MCS, Panels 1-4, authors' unweighted computations.

Estimation Strategy

The estimation strategy closely parallels Chapter 3. Empirical tests of the sample determine whether the assumption of conditional random assignments is plausible, then the relationship between combat experiences and financial problem increases is estimated. Regressions use the GME estimator as the previous rationale, other than small sample size, applies. The principal distinctions from Chapter 3 are estimating the dependent variable over multiple periods, regression models with more than two categories for the dependent variable, and available explanatory variables. The multinomial regression model of financial problem production assumes repeated observations from the same veteran are independent. The assumption follows from viewing each observation of financial problem production as capturing a first-order Markov process of economic well-being. Given the independent observations

assumption, the multinomial regression model estimations, performed with NLOGIT 6.0, pool repeated observations (Greene 2016). The model descriptions introduce available explanatory variables.

Test of Conditional Random Assignments

The model to test the conditional random assignments assumption takes the form of an experiment consisting of N trials. The probabilities of a set of binary random variables, $Assign_{1j}, Assign_{2j}, \dots, Assign_{Nj}$, which equal one if location category j ($j = 1, 2, \dots, J$) is observed for trial i ($i = 1, 2, \dots, N$), are related to a set of explanatory variables with the equation:

$$p_{ij} = \Pr(Assign_{ij} = 1 | \mathbf{M}_i, \mathbf{X}_i) = F(\beta_{0j} + \beta_{1j}' \mathbf{M}_i + \beta_{2j}' \mathbf{X}_i) > 0 \quad (4.1)$$

subject to $\sum_j p_{ij} = 1$. Location categories are created at two levels. At a broader level, the two possible location categories are overseas service inside Iraq or Afghanistan and service outside Iraq or Afghanistan. Since the majority of GWOT deployments fall within a combat zone and data distinguishing combat and non-combat zones is unavailable, service inside Iraq or Afghanistan proxies as service in a war environment. Veterans serve inside Iraq or Afghanistan since the last survey 27 percent of the time. At a more refined level, the three possible location categories are no combat exposure, single combat exposure, and multiple combat exposure. Combat exposure is primarily determined by a veteran indicating personal exposure to witnessing a person's death due to war, disaster, or tragic event in the past three years. In 150 observations where a veteran's primary indication of combat exposure is missing, combat exposure is determined by a veteran indicating seeing Americans who were seriously injured or killed during deployment. Of veterans in the sample with both combat exposure measures, more than 76 percent of veterans indicating combat exposure with the alternate measure also indicate combat exposure with the primary measure. While the alternate deployment specific measure

may be preferable, the MCS did not ask about deployment specific exposure until the 2007-2008 questionnaire. To address misclassification concerns with the primary measure and improve estimates of combat exposure, a binary variable indicating another tragic loss, defined by the death of serious illness of a loved one or family member in the past three years, is included in all models. Veterans report a single combat exposure in the past three years 6 percent of the time, and veterans report more than one combat exposure in the past 3 years 12 percent of the time.

The military vector **M** includes an individual's service entry, years of service, rank, branch, component, and military occupation at the wave prior to the assessment of the development of financial problems. Table 4.2 provides variable definitions and descriptive statistics for the vector **M**.

Table 4.2 Description of Military Control Variables

Variable	Description	Mean	Std. Dev.
Service Entry	Reference group is <i>Initial service in 2001 or earlier</i>		
<i>Post 2001 Entry</i>	Equal to 1 if initial service in 2002 or later, 0	0.37	0.48
Years of Service	Reference group is <i>Less than 7 years of military</i>		
<i>7-12 years</i>	Equal to 1 if years of military service ≥ 7 and < 13 , 0 otherwise	0.21	0.41
<i>13-18 years</i>	Equal to 1 if years of military service ≥ 13 and < 19 , 0 otherwise	0.17	0.37
<i>19 or more years</i>	Equal to 1 if years of military service ≥ 19 , 0	0.23	0.42
Rank	Reference group is <i>Enlisted</i>		
<i>Officer</i>	Equal to 1 if officer rank either W1 or O1 or higher, 0 otherwise	0.30	0.46
Branch of Service	Reference group is service in the <i>Army</i>		
<i>Navy</i>	Equal to 1 if in the Navy or Coast Guard, 0 otherwise	0.15	0.36
<i>Air Force</i>	Equal to 1 if in the Air Force, 0 otherwise	0.32	0.47
<i>Marine Corps</i>	Equal to 1 if in the Marine Corps, 0 otherwise	0.06	0.25
Component	Reference group is <i>Active Duty</i>		
<i>Reserve or National</i>	Equal to 1 if in Reserve or National Guard, 0	0.37	0.48
<i>Separated</i>	Equal to 1 if separated or unknown component, 0 otherwise (some separated respondents return to service)	0.09	0.28
Occupational Classification	Reference group is <i>Combat specialist</i>		
<i>Electrical Repair</i>	Equal to 1 if electrical repair occupation, 0 otherwise	0.09	0.29
<i>Comm/Intel</i>	Equal to 1 if communications/intelligence occupation, 0 otherwise	0.09	0.29
<i>Health care</i>	Equal to 1 if health care occupation, 0 otherwise	0.10	0.30
<i>Other technical</i>	Equal to 1 if other technical or specialty occupation, 0 otherwise	0.03	0.16
<i>Functional support</i>	Equal to 1 if functional support occupation, 0	0.18	0.38
<i>Equipment Repair</i>	Equal to 1 if equipment repair occupation, 0	0.14	0.34
<i>Craft workers</i>	Equal to 1 if craft worker occupation, 0 otherwise	0.03	0.17
<i>Service and Supply</i>	Equal to 1 if service and supply occupation, 0	0.10	0.30
<i>Other</i>	Equal to 1 if other occupation, 0 otherwise	0.04	0.19
Observations		131,036	

Table displays unweighted means of variables generated using survey responses and DMDC data at the wave prior to assessing the development of financial problems.

The vector **X** includes individual and family background variables at the survey prior to deployment assignment that could be associated with combat assignment or the development of financial problems. These variables represent past financial distress, gender, age, race, ethnicity, education, family structure, physical health, mental health, health behaviors, and adverse childhood experiences. Additionally, vector **X** includes macroeconomic measures of the real Gross Domestic Product (GDP) annual growth rate, real military pay annual growth rate, and respective 3 year lags for the survey year. Table 4.3 provides variable definitions and descriptive statistics for vector **X**.

Table 4.3 Description of Non-military Background Variables

Variable	Description	Mean	Std. Dev.
<i>Financial Distress</i>	Equal to 1 if reported stress from financial problems, 0 otherwise	0.33	0.47
<i>Female</i>	Equal to 1 if female gender, 0 otherwise	0.24	0.43
<i>Age</i>	Age in years measured at follow-up survey	37.40	9.32
<i>Age²</i>	Age in years x Age in years measured at follow-up survey	1485.70	764.17
<i>Race & Ethnicity</i>	Reference group is <i>White, Non-Hispanic</i>		
<i>Black</i>	Equal to 1 if black race and non-Hispanic ethnicity, 0 otherwise	0.09	0.29
<i>Other</i>	Equal to 1 if other race and non-Hispanic ethnicity, 0 otherwise	0.11	0.31
<i>Hispanic</i>	Equal to 1 if Hispanic ethnicity, 0 otherwise	0.07	0.25
<i>Education</i>	Reference group is <i>High School or less</i>		
<i>Some College</i>	Equal to 1 if only some college education, 0 otherwise	0.48	0.50
<i>College Degree</i>	Equal to 1 if Bachelor's degree or higher, 0 otherwise	0.40	0.49
<i>Family Structure</i>			
<i>Dependents</i>	Equal to number of dependents in military record. Last known value used if value missing at prior survey.	1.54	1.51
<i>Recent divorce</i>	Equal to 1 if divorced or separated in past 3 years (or ever if baseline survey), 0 otherwise	0.13	0.33
<i>Health</i>			
<i>PCS</i>	Physical health component score*	54.13	6.72
<i>MCS</i>	Mental health component score*	52.48	8.47
<i>Smoking</i>	Equal to 1 if past year smoked cigarettes (ever smoked 100 cigarettes if baseline survey), 0 otherwise	0.28	0.45
<i>Heavy drinking</i>	Equal to 1 if 15 (8) drinks or more during a typical week for men (women), 0 otherwise	0.07	0.25
<i>Childhood</i>			
<i>Neglect</i>	Equal to 1 if respondent indicated grown-ups did not take care of them in the way that they should before the age of 18, 0 otherwise. Examples of neglect in question include respondent not getting enough food, receiving medical care when sick, and having a safe place to stay.	0.07	0.25
<i>Verbal abuse</i>	Equal to 1 if respondent indicated grown-ups made them feel scared or really bad by saying mean things to them before the age of 18, 0 otherwise	0.18	0.39
<i>Physical abuse</i>	Equal to 1 if respondent indicated grown-ups hit (not including spanking on the bottom), beat, kicked, or physically hurt them before the age of 18, 0 otherwise	0.25	0.43
<i>Sexual abuse</i>	Equal to 1 if respondent indicated grown-ups touched private parts when they shouldn't have, made them touch their private parts, or forced them to have sex, 0 otherwise	0.08	0.27
<i>Macroeconomic</i>			
<i>GDP growth</i>	Real US GDP annual growth rate at follow-up survey year Source: US Department of Commerce	2.21	0.89
<i>Laq GDP</i>	GDP growth 3 years prior to follow-up survey year	1.37	1.72
<i>Military pay</i>	Real US military pay annual growth rate at follow-up survey year. Source: Defense Finance and Accounting Service	0.48	1.34
<i>growth</i>			
<i>Laq Military pay</i>	Military pay growth 3 years prior to survey follow-up year	1.08	1.19
Observations		131,036	

Table displays unweighted means of variables generated using survey responses and DMDC data at the wave prior to assessing the development of financial problems unless otherwise noted. Description of dummy variables for missing family structure, health, health behaviors, and childhood variable responses not displayed.

*- The MCS and PCS are standard health instruments commonly used in veteran studies. Higher scores imply better health. The scores are derived from 36 five-choice ordinal scale questions in eight health domains. The eight health domains are: physical functioning, role limitations due to physical problems, bodily pain, general health perceptions, energy/vitality, social functioning, role limitations due to emotional problems, and mental health. The transformation of the questions into the uncorrelated component summary scales is accomplished

Variable	Description	Mean	Std. Dev.
	using weights derived from a national probability sample of the US population, and the scales are standardized so the MCS and PCS have a direct interpretation to a US population mean of 50 and standard deviation of 10 (Hays, Sherbourne, and Mazel 1993; Kazis et al. 2004)		

The scalars β_{0j} represents the function intercepts, the coefficient vectors β_{1j}' measures whether military observables explain location assignment, and the coefficient vectors β_{2j}' measures whether background variables explain location assignment. The $F(\cdot)$ is the function linking the probability with the covariates for an individual. If deployment location assignment is exogenous to an individual's development of financial problems, then the coefficient vectors β_{2j}' should not help explain the location assignment. To make model interpretation more tangible, results display the estimated marginal effect of each independent variable on the overall probability of observing a category. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean.

Table 4.4 Marginal Effects of Background Characteristics on Location Assignment Probabilities

	(1) Iraq or Afghanistan Inside		(2) None		(3) Combat Exposure Single		(4) Multiple	
Non-military variables	Effect	SE	Effect	SE	Effect	SE	Effect	SE
<i>Financial Distress</i>	-0.0154	0.0024	0.0057	0.0021	-0.0003	0.0014	-0.0054	0.0016
<i>Female</i>	-0.0365	0.0027	0.0719	0.0022	-0.0143	0.0015	-0.0576	0.0016
<i>Age</i>	0.0044	0.0003	0.0007	0.0002	-0.0006	0.0002	-0.0001	0.0002
<i>Race</i>								
<i>Black</i>	-0.0120	0.0037	0.0236	0.0032	0.0054	0.0023	-0.0290	0.0023
<i>Other</i>	-0.0212	0.0033	0.0067	0.0030	0.0004	0.0021	-0.0071	0.0022
<i>Hispanic</i>	-0.0122	0.0042	0.0090	0.0037	0.0037	0.0025	-0.0127	0.0027
<i>Education</i>								
<i>Some College</i>	-0.0087	0.0035	-0.0129	0.0031	0.0011	0.0019	0.0118	0.0024
<i>College Degree</i>	-0.0223	0.0047	-0.0034	0.0041	-0.0019	0.0026	0.0053	0.0033
<i>Family Structure</i>								
<i>Dependents</i>	0.0026	0.0009	-0.0004	0.0008	0.0004	0.0005	0.0000	0.0006
<i>Divorce</i>	-0.0010	0.0033	-0.0191	0.0030	0.0068	0.0019	0.0124	0.0024
<i>Health</i>								
<i>PCS</i>	0.0040	0.0002	0.0016	0.0001	-0.0005	0.0001	-0.0011	0.0001
<i>MCS</i>	0.0014	0.0001	0.0009	0.0001	-0.0004	0.0001	-0.0005	0.0001
<i>Smoking</i>	0.0099	0.0026	-0.0139	0.0023	0.0061	0.0015	0.0078	0.0018
<i>Heavy Drinking</i>	0.0097	0.0045	-0.0062	0.0039	-0.0040	0.0023	0.0102	0.0031
<i>Childhood Experiences</i>								
<i>Neqlect</i>	0.0083	0.0050	-0.0204	0.0044	0.0048	0.0027	0.0156	0.0035
<i>Verbal Abuse</i>	0.0002	0.0035	-0.0103	0.0031	0.0059	0.0020	0.0044	0.0024
<i>Physical Abuse</i>	0.0080	0.0031	-0.0276	0.0028	0.0081	0.0018	0.0196	0.0022
<i>Sexual Abuse</i>	-0.0026	0.0044	-0.0038	0.0039	0.0023	0.0025	0.0015	0.0030
Observations	131,036				131,036			
Pseudo-R ²	0.30				0.52			
Pseudo-R ² (military only)	0.29				0.51			

Column 1 displays GME marginal effects for multinomial country assignment model. Columns 2-4 display GME marginal effects for multinomial combat exposure assignment model. SE = Standard error. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean. All columns include military control variables in Table 4.2 and macroeconomic variables in Table 4.3. All columns include dummy variables for missing values of family structure, health, health behaviors, and childhood experiences.

Table 4.4 reveals support for the assumption of conditional random assignments with model fit statistics and estimated marginal effects of individual non-military variables on the different location assignment possibilities. The Pseudo-R² measure captures the goodness of fit between the sample information and the model on an increasing scale of 0 to 1 by comparing the (maximized) entropy of the fitted model with the entropy of the uniform distribution (Golan 2018). The inclusion of all individual non-military background variables in models in both columns increases respective Pseudo-R² goodness of fit measures by only one hundredth relative to models without individual non-military background variables. The measures indicate non-

military background characteristics, as a whole, do little to explain dispersion in location assignments. Column 1 shows the influence of each individual non-military background variable on assignment probability inside a war environment generally is no more than about two percent. In the model of combat exposure assignment, Columns 2 through 4 shows the influence of each individual non-military background variable on the assignment probabilities to combat exposure is generally no more than about two percent. Gender is the only consistent exception, and the results indicate women are less likely to be assigned to a war environment or combat exposure. A reasonable explanation in line with exogenous selection is previous policies limiting the role of women in combat (see Cesur, Chesney, and Sabia 2016 for full discussion). Although the potential for endogenous selection cannot be completely ruled out, the results, taken together, provide support for the conditional random assignments assumption.

Effects of Combat Experiences on the Development of Financial Problems

Incorporating the assumption of conditional random assignments into the conceptual framework's equation 2.3, the model to determine the conditional effect of combat experiences on the development of financial problems takes the form of an experiment consisting of N trials. The probabilities of a set of binary random variables, $Y_{1j}, Y_{2j}, \dots, Y_{Nj}$, which equal one if state j ($j = 1, 2, 3, 4$) corresponding to *None*, *Distress only*, *Major problem only*, and *Major Problem & Distress* is observed for trial i ($i = 1, 2, \dots, N$), are related to explanatory variables with the equation:

$$p_{ij} = \Pr(Y_{ij} = 1 | \mathbf{M}_i, \mathbf{X}_i) = F(\delta_{0j} + \delta_{1j}'\mathbf{D} + \pi_{1j}'\mathbf{M} + \pi_{2j}'\mathbf{X}) > 0 \quad (4.2)$$

subject to $\sum_j p_{ij} = 1$. $F(\cdot)$ is the function linking the probability of a state with the covariates for an individual. The scalars δ_{0j} are the function intercepts. The vector $\mathbf{D}$ includes deployment

experiences including the relevant location assignment and time spent deployed, and the coefficient vectors δ_{1j}' shows how vector **D** is associated with the probability of developing financial problems. The vectors **M** and **X** are as previously described, and coefficient vectors π_{1j}' and π_{2j}' explain how the variables in **M** and **X** relate to the development of financial problems. The validity of the exogeneity assumption can be further assessed by estimating equation 4.2 without the individual non-military background variables in vector **X**. If the exogeneity assumption is valid, then the marginal effects of the location assignments should be stable.

Estimates of the Effects of Combat Experiences on the Development of Financial Problems

Estimated marginal effects of service in a war environment on the development of financial problems as described in equation 4.2 are not significantly different than zero and not displayed. Table 4.5 provides estimated marginal effects of combat exposure and other deployment related variables on the development of financial problems. After comparing models with and without individual non-military background variables, the possibility of the effect of combat exposure extending into other survey periods is examined. Graphical analysis examines predicted variation in the effect of combat exposure on an increase in both a major problem and distress with background characteristics. Finally, estimates with alternate measures of combat exposure demonstrate the robustness of findings.

Table 4.5 results suggest detrimental effects to economic well-being from combat exposure. The results highlight the value added by specific combat exposure measures as Iraq or Afghanistan service measure mask important heterogeneity below country level. For Table 4.5, the model in column 1 with only military variables and the model in column 2 with both military

and other control variables lead to the same conclusions. The estimated marginal effects of combat exposure on the state of no financial decline are negative, and the estimated marginal effects of combat exposure on an increase in financial distress only, an increase in a major financial problem only, and an increase in distress and a major problem are consistently positive. A single combat exposure increases the probability of developing a major problem and distress by about half a percentage point, and multiple combat exposures increase the probability of developing a major problem and distress by about one percentage point. The influence of combat exposure is substantial relative to the 2.1 percent average predicted probability of developing a major problem and distress.

The inclusion of individual non-military background variables in Table 4.5 has little influence on the magnitude of findings, and a comparison of estimates provides further support for the conditional independence of location assignments to personal characteristics. An informal gauge of the strength of likely bias from unobservable characteristics can be calculated by dividing the marginal effect of combat exposure in column 2 by its difference with the marginal effect in column 1 (Altonji, Elder, and Taber 2005). Using the conditional share weighted average effect of combat exposure on the probability of developing a major problem and distress, the computed ratio implies selection on unobservable characteristics would need to be nearly five times greater than selection on non-military background variables, including the previous level of financial distress, to explain away the estimated effect. The Pseudo- R^2 measures indicate including non-military background variables improves goodness of model fit, thus models including non-military background variables represent preferred specifications.

Combat exposure is not the only deployment related factor influencing the probability of developing financial problems. Table 4.5 shows deployed time reduces the probability of

developing financial problems. The estimate of the conditional share weighted average effect of deployed time on developing a major problem and distress is similar in magnitude to the conditional share weighted average effect of combat exposure, and the results suggest deployment time, possibly due to temporary increases in pay and benefits, can help counterbalance harmful effects of combat exposure. On the other hand, physical illness or disability during the survey period results increases the estimated probability of developing a major problem and distress by more than two percentage points. The influence of other tragic losses involving a veteran's family or loved ones on financial decline appears similar to influence of combat exposure on financial decline, and the results suggest inclusion of other tragic losses in the model helps reduce possible conflating of estimates of combat and non-combat traumatic experiences that could be captured by the defined combat exposure variable. As the primary interest is in the consequences of combat experiences, the influence of all background variables on the development of financial problems is described in Appendix A, Table A4.1.

Table 4.5 Marginal Effects of Deployment Related Variables on Financial Problem Development

	(1) Military Only		(2) Military and Non-Military	
	Effect	SE	Effect	SE
Probability (Y=None)				
Combat Exposure (reference is none)				
<i>Single</i>	-0.0338	0.0053	-0.0260	0.0051
<i>Multiple</i>	-0.0395	0.0041	-0.0306	0.0039
<i>Weighted average of exposure*</i>	-0.0377	0.0034	-0.0291	0.0033
Deployed time (reference is none)				
<i>Deployed 1-179 days</i>	0.0230	0.0033	0.0231	0.0031
<i>Deployed 180-364 days</i>	0.0309	0.0032	0.0267	0.0032
<i>Deployed 365 days or more</i>	0.0450	0.0049	0.0437	0.0047
<i>Weighted average of deployed time*</i>	0.0291	0.0026	0.0273	0.0025
<i>Disabling illness or injury</i>	-0.1362	0.0059	-0.1029	0.0058
<i>Other tragic loss</i>	-0.0317	0.0024	-0.0291	0.0024
Probability (Y=Distress Only)				
Combat Exposure (reference is none)				
<i>Single</i>	0.0266	0.0051	0.0215	0.0049
<i>Multiple</i>	0.0249	0.0039	0.0193	0.0038
<i>Weighted average of exposure*</i>	0.0254	0.0032	0.0200	0.0032
Deployed time (reference is none)				
<i>Deployed 1-179 days</i>	-0.0185	0.0030	-0.0207	0.0029
<i>Deployed 180-364 days</i>	-0.0221	0.0030	-0.0206	0.0029
<i>Deployed 365 days or more</i>	-0.0311	0.0046	-0.0322	0.0043
<i>Weighted average of deployed time*</i>	-0.0220	0.0025	-0.0227	0.0024
<i>Disabling illness or injury</i>	0.0868	0.0055	0.0681	0.0055
<i>Other tragic loss</i>	0.0233	0.0023	0.0231	0.0023
Probability (Y=Major Problem Only)				
Combat Exposure (reference is none)				
<i>Single</i>	0.0016	0.0013	0.0005	0.0009
<i>Multiple</i>	0.0043	0.0011	0.0025	0.0008
<i>Weighted average of exposure*</i>	0.0034	0.0009	0.0018	0.0007
Deployed time (reference is none)				
<i>Deployed 1-179 days</i>	-0.0017	0.0007	-0.0007	0.0006
<i>Deployed 180-364 days</i>	-0.0028	0.0007	-0.0015	0.0006
<i>Deployed 365 days or more</i>	-0.0035	0.0010	-0.0021	0.0008
<i>Weighted average of deployed time*</i>	-0.0025	0.0006	-0.0012	0.0005
<i>Disabling illness or injury</i>	0.0147	0.0018	0.0090	0.0013
<i>Other tragic loss</i>	0.0029	0.0006	0.0015	0.0005
Probability(Y= Major Problem & Distress)				
Combat Exposure (reference is none)				
<i>Single</i>	0.0062	0.0016	0.0044	0.0015
<i>Multiple</i>	0.0107	0.0013	0.0090	0.0013
<i>Weighted average of exposure*</i>	0.0089	0.0010	0.0074	0.0010
Deployed time (reference is none)				
<i>Deployed 1-179 days</i>	-0.0021	0.0008	-0.0012	0.0008
<i>Deployed 180-364 days</i>	-0.0052	0.0007	-0.0038	0.0008
<i>Deployed 365 days or more</i>	-0.0086	0.0008	-0.0078	0.0009
<i>Weighted average of deployed time*</i>	-0.0046	0.0007	-0.0033	0.0007
<i>Disabling illness or injury</i>	0.0347	0.0023	0.0258	0.0021
<i>Other tragic loss</i>	0.0055	0.0006	0.0046	0.0007
Observations	131,036		131,036	
Pseudo-R ²	0.52		0.55	

GME marginal effects for multinomial models displayed. SE=Standard Error. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean. Column 1 includes military control variables in Table 4.2 and macroeconomic variables in Table 4.3. Column 2 includes Column 1 variables and all other background variables in Table 4.3 and dummy variables for missing values of family structure, health, health behaviors, and childhood

	(1)	(2)
	Military Only	Military and Non-Military
	Effect	Effect
	SE	SE
experiences. *- weighted average of unspecified switch from reference category computed using sample shares of each category		

Variation in Effects of Combat Exposure over Time

To evaluate whether any effects of combat exposure are delayed or anticipatory, combat exposures reported in other survey periods are included in the model. Columns 1 and 2 in Table 4.6 reveal that any influence of combat exposure from the prior survey periods on the probability of developing financial problems is rather limited, and the results consistently find combat exposure in the most recent three-year survey period associated with a decline in economic well-being. As expected, the results from the inclusion of the one period lead of combat exposure in column 3 suggest the development of financial problems does not result from any behavior anticipating combat exposure.

Table 4.6 Marginal Effects of Combat Exposure over Time on Financial Problem Development

	(1)		(2)		(3)	
	Effect	SE	Effect	SE	Effect	SE
Probability (Y=None)						
Combat Exposure						
<i>Single</i>	-0.0251	0.0052	-0.0312	0.0076		
<i>Multiple</i>	-0.0286	0.0041	-0.0344	0.0060		
1-Period Lag Combat Exposure						
<i>Single</i>	-0.0091	0.0043	-0.0091	0.0066		
<i>Multiple</i>	-0.0064	0.0035	-0.0084	0.0052		
2-Period Lag Combat Exposure						
<i>Single</i>			-0.0083	0.0057		
<i>Multiple</i>			0.0051	0.0047		
1-Period Lead Combat Exposure						
<i>Single</i>					-0.0014	0.0064
<i>Multiple</i>					0.0101	0.0046
Probability (Y=Distress Only)						
Combat Exposure						
<i>Single</i>	0.0205	0.0050	0.0265	0.0073		
<i>Multiple</i>	0.0175	0.0039	0.0226	0.0057		
1-Period Lag Combat Exposure						
<i>Single</i>	0.0069	0.0041	0.0075	0.0064		
<i>Multiple</i>	0.0056	0.0034	0.0064	0.0050		
2-Period Lag Combat Exposure						
<i>Single</i>			0.0075	0.0055		
<i>Multiple</i>			-0.0060	0.0045		
1-Period Lead Combat Exposure						
<i>Single</i>					0.0023	0.0064
<i>Multiple</i>					-0.0120	0.0046
Probability (Y=Major Problem Only)						
Combat Exposure						
<i>Single</i>	0.0005	0.0010	-0.0006	0.0011		
<i>Multiple</i>	0.0025	0.0009	0.0027	0.0011		
1-Period Lag Combat Exposure						
<i>Single</i>	-0.0005	0.0008	-0.0003	0.0010		
<i>Multiple</i>	-0.0001	0.0006	-0.0002	0.0008		
2-Period Lag Combat Exposure						
<i>Single</i>			-0.0003	0.0009		
<i>Multiple</i>			0.0010	0.0008		
1-Period Lead Combat Exposure						
<i>Single</i>					-0.0008	0.0015
<i>Multiple</i>					0.0003	0.0012
Probability(Y= Major Problem & Distress)						
Combat Exposure						
<i>Single</i>	0.0041	0.0014	0.0061	0.0022		
<i>Multiple</i>	0.0086	0.0013	0.0091	0.0019		
1-Period Lag Combat Exposure						
<i>Single</i>	0.0027	0.0011	0.0019	0.0017		
<i>Multiple</i>	0.0009	0.0009	0.0022	0.0013		
2-Period Lag Combat Exposure						
<i>Single</i>			0.0011	0.0014		
<i>Multiple</i>			-0.0001	0.0011		
1-Period Lead Combat Exposure						
<i>Single</i>					-0.0001	0.0014
<i>Multiple</i>					0.0016	0.0012
Observations	130,950		70,916		72,100	
Pseudo-R ²	0.55		0.55		0.57	

GME marginal effects for multinomial models displayed. SE=Standard Error. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean. All columns include military control variables in Table 4.2, all

other deployment related variables in Table 4.5, all other background variables in Table 4.3 and dummy variables for missing values of family structure, health, health behaviors, and childhood experiences.

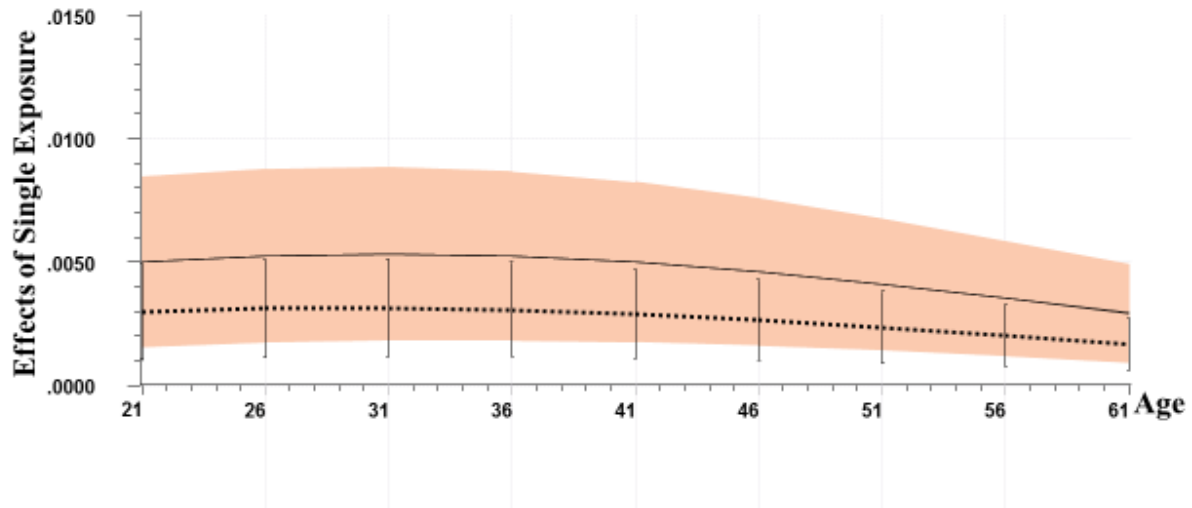
Variation in Effects of Combat Exposure with Background Characteristics

Groups of veterans with different background characteristics may be more or less resilient to combat exposure. While the marginal effects computed with all other variables set to sample means provide insight at one important point, estimates with a range of values for background characteristics help us understand how the predicted effect of combat exposure on development of both a major problem and distress changes. Figures 4.2 and 4.3, generated using parameters estimated for the Table 4.5 model specification with all background variables, illustrate variation in the effects of combat exposure among veterans of different rank, age, and health. Unobservable differences may also exist among some groups of veterans in the full sample; however, estimates, displayed graphically in figure A4.1, from samples divided by gender, samples divided by military service component, samples divided by combat specialist and non-combat specialist occupations, samples divided by military service entry period, and samples divided by prior financial stress appear consistent with estimates from the sample with all groups.

Figure 4.2 reveals predicted variation in the effect of combat exposure on the development of financial problems over rank and age. The variation in the effects exhibit similar patterns for single and multiple exposures, but the variation is more pronounced for multiple exposures. As higher military rank and years of service equate to higher military pay that can provide a financial buffer, it is not surprising the oldest officers are the least vulnerable to effects of combat exposure. Interestingly, the veterans most vulnerable to effects of combat exposure are not the youngest enlisted veterans, but enlisted veterans around 30 years old. Possible

explanations for the finding include the youngest veterans having fewer responsibilities and the military placing more restrictions on the youngest veterans (e.g. unable to live off base).

Marginal Effects of Single Exposure by Rank at Ages on Probability(Major Problem & Distress)



Marginal Effects of Multiple Exposure by Rank at Ages on Probability(Major Problem & Distress)

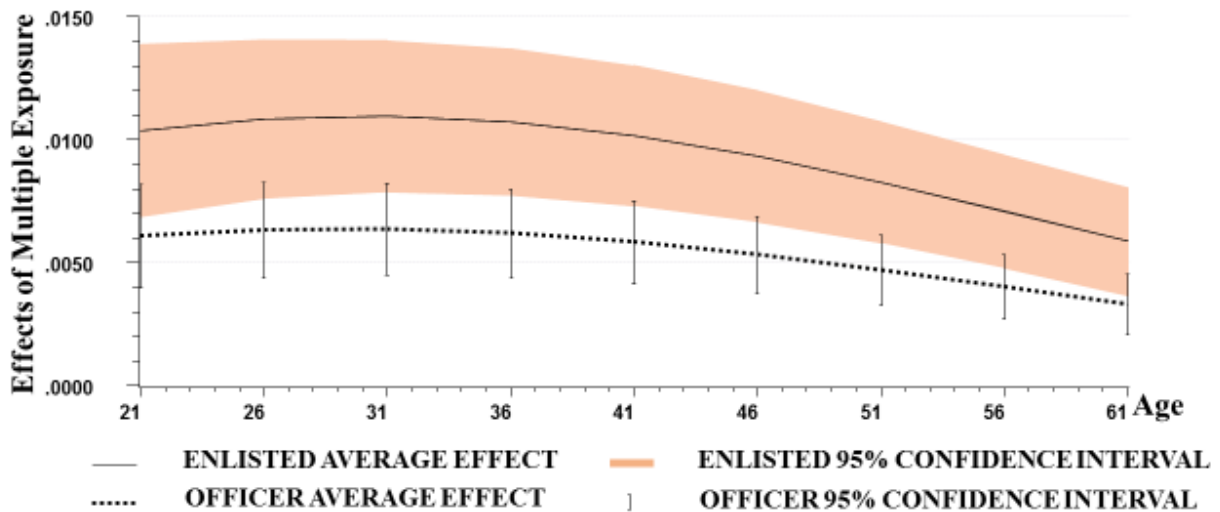
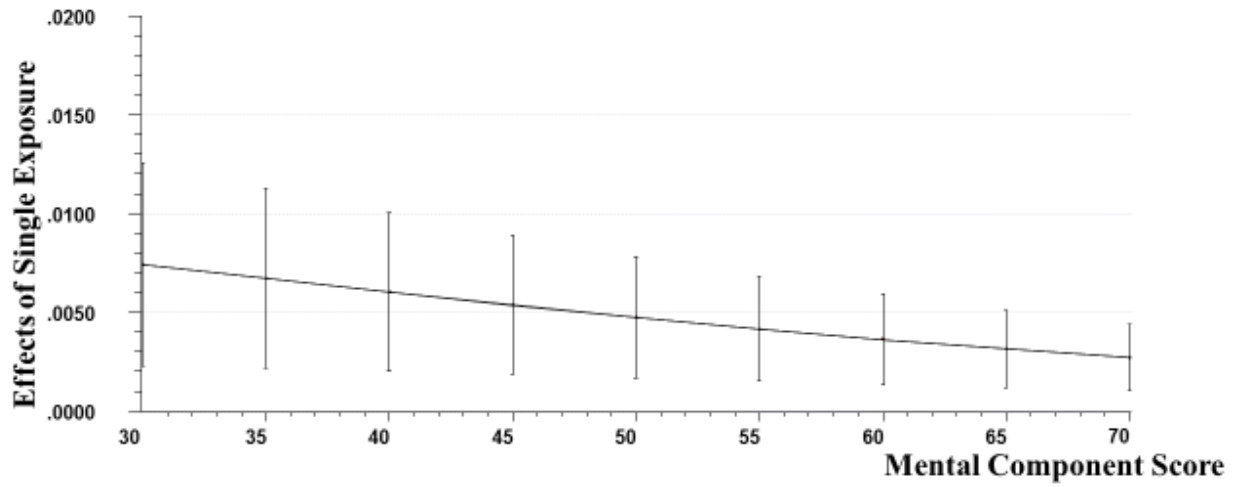


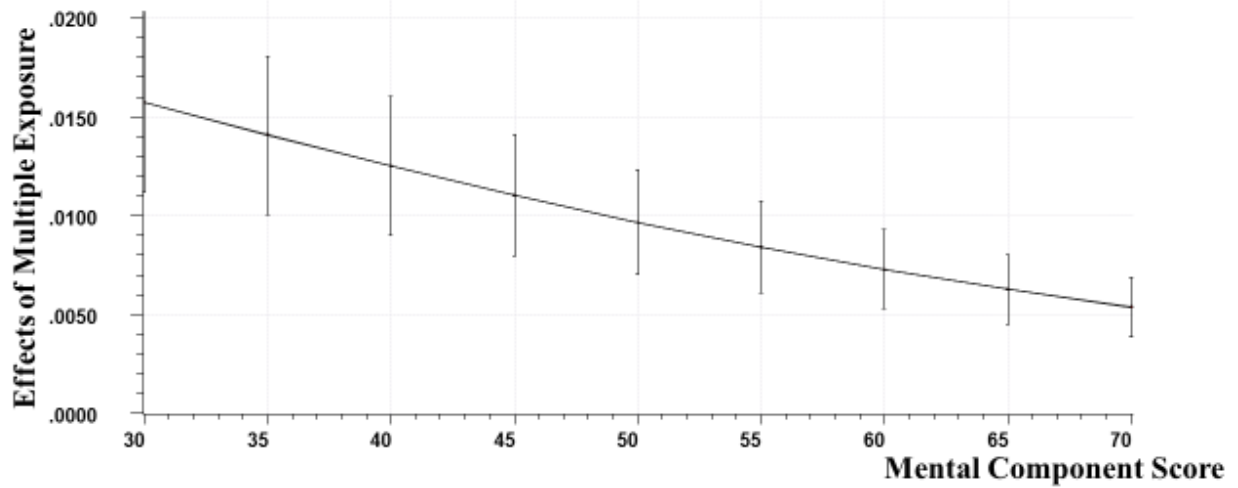
Figure 4.2 Marginal Effects of Combat Exposure by Rank at Ages on Probability (Major Problem & Distress)
 GME marginal effects for categorical values of combat exposure and rank computed by setting all observations to category value and comparing to respective base value with age set to values 21, 26,...,56,61 and all other variables set to sample means. Model includes military control variables in Table 4.2, all deployment related variables in Table 4.6, all other background variables in Table 4.3 and dummy variables for missing values of family structure, health, health behaviors, and childhood experiences.

Figure 4.3 reveals veterans with poorer pre-deployment self-reported health scores appear more vulnerable to the effects of combat exposure on the development of financial problems. The variation in the effects exhibit similar patterns for combat exposure frequency and health category, but the variation is more pronounced for multiple exposures and mental health. Each 10-point, or one standard deviation for the US population, mental component score decline translates to the marginal effect of multiple combat exposure on the probability of developing a financial stress and a major financial problem increasing roughly 0.3 percentage-points. The findings suggest increased health capital, a non-monetary resource, can lessen the impact of traumatic exposure on the development of financial problems.

**Marginal Effects of Single Exposure
at Mental Component Scores on Probability(Major Problem & Distress)**



**Marginal Effects of Multiple Exposure
at Mental Component Scores on Probability(Major Problem & Distress)**



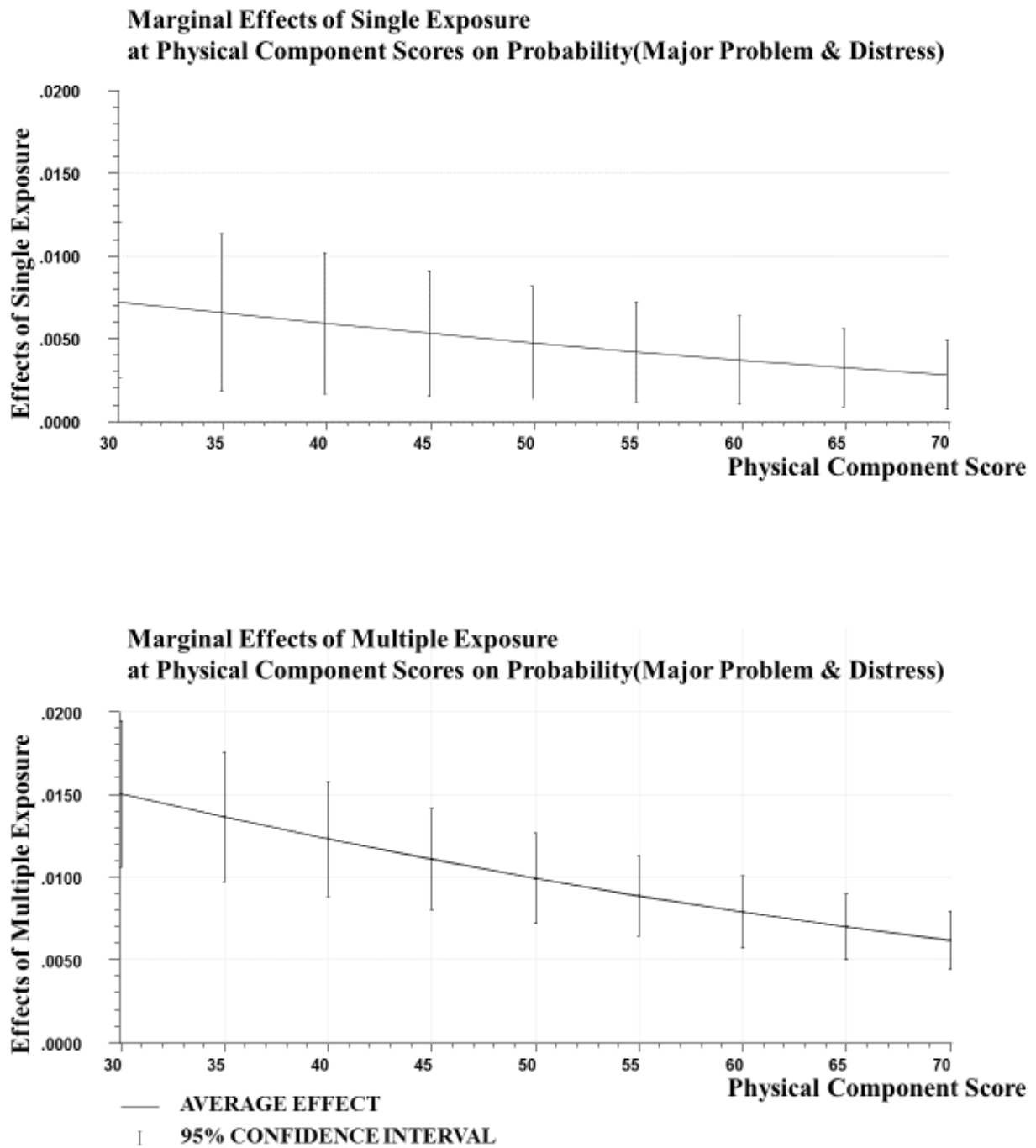


Figure 4.3 Marginal Effects of Combat Exposure at Health Scores on Probability (Major Problem & Distress)
 GME marginal effects for categorical values of combat exposure computed by setting all observations to category value and comparing to base value with health score set to values 30,35,...,65,70 and all other variables set to sample means. Model includes military control variables in Table 4.2, all other background variables in Table 4.3 and dummy variables for missing values of family structure, health, health behaviors, and childhood experiences.

Additional Robustness Checks

Alternate measures of combat exposure were substituted into the model to evaluate the robustness of the main finding, the marginal effect of combat exposure on the probability of developing financial distress and a major financial problem. The 2007 survey introduced questions regarding the frequency that veterans experienced enemy attacks or ambushes and improvised explosive devices (IEDs) during deployments in the past 3 years. Columns 2 and 3 of Table 4.7 display estimates for the alternate combat exposure measures, created from the 2007 and later survey question responses, that are similar to the estimates of the primary measure of combat exposure in column 1.

The 2011 survey introduced a question enabling a falsification test of the main finding. Specifically, the survey asked veterans about the frequency of exposure to smoke from burning trash or feces during deployments in the past 3 years. Smoke exposure from burning trash or feces seems unlikely to test a veteran's understanding of the world or change financial behaviors. Though smoke exposure in some veterans could have caused health conditions with major financial consequences, the inclusion of controls for disability or illness in the model make any expected influence of smoke exposure on the development of financial problems small. Table 4.7 column 4 displays results for estimations with the smoke exposure measures, created from the 2011 and later survey question responses, substituted for the primary combat exposure measures, and Table 4.7 column 5 displays results for estimations with the smoke exposure measures and the primary combat exposure measures. The results provide support for the hypothesis that combat exposure leads to the development of financial problems.

Table 4.7 Marginal Effects of Other Combat Measures on Probability (Major Problem & Distress)

	(1)		(2)		(3)		(4)		(5)	
	Effect	SE	Effect	SE	Effect	SE	Effect	SE	Effect	SE
Combat exposure										
<i>Single</i>	0.0039	0.0018							0.0017	0.0022
<i>Multiple</i>	0.0094	0.0015							0.0087	0.0020
<u>Other measures</u>										
Attacked										
<i>Single</i>			0.0049	0.0019						
<i>Multiple</i>			0.0069	0.0011						
IED										
<i>Single</i>					0.0032	0.0019				
<i>Multiple</i>					0.0067	0.0015				
Smoke										
<i>Single</i>							0.0003	0.0033	0.0003	0.0032
<i>Multiple</i>							0.0037	0.0012	0.0021	0.0012
Observations	57,221		57,221		57,221		32,516		32,516	
Pseudo-R ²	0.56		0.56		0.56		0.55		0.55	

Estimates for *None*, *Distress only* and *Major problem only* states not displayed. GME marginal effects for multinomial models displayed. SE=Standard Error. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean. All columns include military control variables in Table 4.2, all other deployment related variables in Table 4.5, all other background variables in Table 4.3 and dummy variables for missing values of family structure, health, health behaviors, and childhood experiences.

Summary of Results and Discussion

Finances are the most commonly reported stressor for the US population and most Americans experience multiple traumatic events (Kilpatrick et al. 2013; American Psychological Association 2015), yet this is the first study (to the best of the authors' knowledge) measuring the movement to a lower state of economic well-being following traumatic exposure. The results consistently support the hypothesis that combat exposure is associated with financial declines for deployed veterans. The results indicate, on average, the probability of developing a new major financial problem (such as bankruptcy) and greater financial distress increases 0.44 percentage points (21 percent relative to the mean probability) following a single combat exposure and increases 0.90 percentage points (43 percent relative to the mean probability) following multiple combat exposures. Given a conservative estimate of 10 percent productivity reduction in workers

with personal financial problems from civilian research (Garman, Leech, and Grable 1996) and an approximate annual basic pay of \$38,000 (not counting local allowances for housing, sustenance, or deployments) for a 29-year-old enlisted (E-5) service member in 2016, the marginal effects of combat exposure on major financial problems and distress translate to roughly \$50-\$100 per veteran in lost productivity costs over a 3-year period. Assuming uniform deployment of the 2.7 million veterans from 2001 to 2016 and average rates of combat exposure reported in the study, \$40.5 million represents a conservative estimate of short-term productivity losses due to combat exposure in recent overseas operations. Moreover, the estimate does not capture the financial problem related costs to individual health, military security, military recruitment, or long-term productivity.

The current study also stands out among other economic studies using longitudinal data to identify deleterious influences of combat exposure on non-market outcomes (Cesur, Sabia, and Tekin 2013, 2015; Cesur, Chesney, and Sabia 2016; Cesur and Sabia 2016; Armey and Lipow 2016) because simulation results help identify policy relevant characteristics that may be targeted before a veteran is sent into harm's way. The results point towards veterans with poorer pre-deployment mental or physical health, veterans in enlisted ranks, and veterans between the ages of 26 and 36 as being less resilient to the effects of combat exposure on financial problems. Additionally, as Edwards (2015) economic study with cross-sectional data revealed no significant association between household income and combat exposure, the current study highlights the value added by examining variation within individuals and with alternate economic measures to understand the impact of combat exposure on economic well-being.

CHAPTER 5

COMBAT AND HOMELESSNESS

Chapter 3 and 4 analyses uncover health and functional consequences following combat experiences. This chapter analyzes whether homelessness also likely follows combat experiences. The chapter first discusses the data, then, it presents the estimation strategy and findings. It concludes with a discussion of the results.

Data: Millennium Cohort Study and Defense Manpower Data Center

MCS and DMDC data, the same sources described in Chapter 4, provide the sample for analysis. The sample includes Panel 1, 2, 3, and 4 veterans with military service entry and current service information at the 2011-2013 survey cycle likely eligible for combat experiences prior to the 2011-2013 survey cycle. The sample includes veterans with any Global War on Terror deployments prior to the 2014-2016 survey cycle and non-missing information on combat exposure at the group baseline survey and prior to the 2011-2013 survey cycle. The sample includes 71,261 veterans at the 2011-2013 survey cycle, and 50,698 veterans provide valid responses in the 2014-2016 survey cycle for the assessment of homelessness. The 2014-2016 survey cycle is the only cycle to ask questions about homelessness. After excluding an additional 176 veterans with missing or invalid information for age, gender, race, ethnicity, or education, the full sample includes 50,522 deployed veterans.

Homelessness Measures

Two measures of homelessness are constructed with the data. The primary measure, a binary variable, captures homelessness occurring between 2011 and the 2014-2016 survey cycle. Homelessness is defined as a veteran having ever found it necessary, during or after military

service, to sleep for any length of time in a shelter, on the streets, or in another non-residential setting because of having no other place to stay and not indicating the most recent episode started prior to 2011. The definition does not include veterans “doubled up” in residential settings with family, friends, or other non-relatives who are considered homeless by the McKinney-Vento Homeless Assistance Act of 1987. About 80 percent of reported homeless start dates occur in 2011 or later. The assumption of homeless veterans not reporting a start date having a homeless episode in 2011 or later removes the chance of analyzing homelessness before combat experiences. In the sample of veterans eligible for combat assignments prior to the 2011-2013 survey cycle, 1.50 percent of the sample, or 759 veterans, report homelessness.

The alternate homelessness measure comes at the cost of removing the roughly one-third of the primary measure’s homeless episodes reported without dates, but the alternate homelessness measure does not require the assumption homeless episodes reported without dates occur before combat experiences and permits inference about the sensitivity of estimates to different homeless episode durations. Figure 5.1 displays the distribution of the duration of the most recent homeless episodes in months reported by 424 veterans, or 0.84 percent of the updated sample. The median duration of homeless episodes is 3 months, and the average duration of homeless episodes is 9 months. The alternate homelessness measure is a multinomial variable with three mutually exclusive states; veterans experience no homeless episode (99.16 percent), a short homeless episode of 3 months or less (0.46 percent), or a long homeless episode of more than 3 months (0.38 percent). Measures that instead use 2 or 4 months to delineate homeless episode durations did not qualitatively change estimation results.

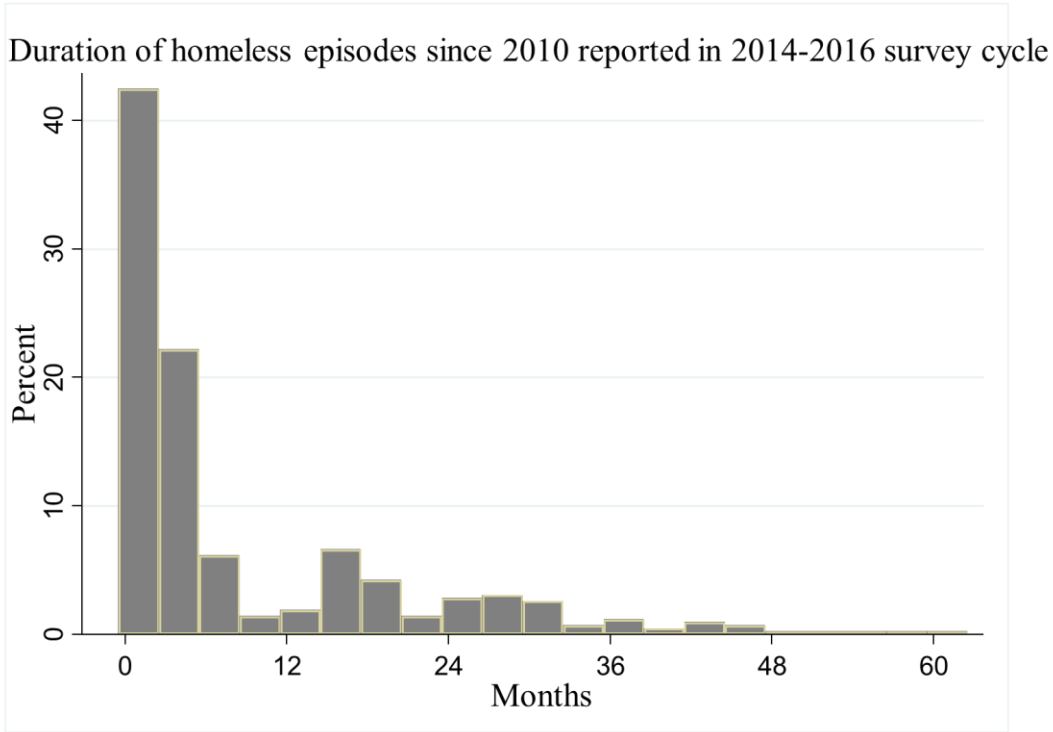


Figure 5.1 Duration of Homeless Episodes since 2010 Reported in 2014-2016 Survey Cycle
 Author's calculations based on 2014-2016 survey cycle responses of 424 veterans.

Estimation Strategy

The estimation strategy is similar to the previous two chapters; however, the core model to determine the conditional effect of combat experiences on homelessness is introduced prior to empirical tests of the conditional random assignments assumption. Regressions use the GME estimator as previous rationale applies, and regressions are performed with NLOGIT 6.0 (Greene 2016). Model descriptions introduce explanatory variables.

Incorporating the assumption of conditional random assignments into the conceptual framework's equation 2.3, the model to determine the conditional effect of combat experiences on homelessness takes the form of an experiment consisting of N trials. The probabilities of a set of binary random variables, $Y_{1j}, Y_{2j}, \dots, Y_{Nj}$, which equal one if j , representing a state of homelessness, is observed for trial i ($i = 1, 2, \dots, N$), are related to explanatory variables with the equation:

$$p_{ij} = \Pr(Y_{ij} = 1 | \mathbf{M}_i, \mathbf{X}_i) = F(\delta_{0j} + \delta_{1j}'\mathbf{D} + \pi_{1j}'\mathbf{M} + \pi_{2j}'\mathbf{X}) > 0 \quad (5.1)$$

subject to $\sum_j p_{ij} = 1$. $F(\cdot)$ is the function linking the probability of a state with the covariates for an individual. The scalars δ_{0j} are the function intercepts. The vector $\mathbf{D}$ includes deployment experiences including the relevant location assignment and time spent deployed, and the coefficient vectors δ_{1j}' shows how vector $\mathbf{D}$ is associated with the probability of a homelessness level. The vector $\mathbf{M}$ is a set of individual military variables, and the vector $\mathbf{X}$ is set of individual background variables that may influence homelessness. The coefficient vectors π_{1j}' and π_{2j}' explain how the variables in $\mathbf{M}$ and $\mathbf{X}$ relate to a homelessness level. To make model interpretation more tangible, all results display the estimated marginal effect of each independent variable on the overall probability of observing a state. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean.

In an ideal data set, the variables in vectors $\mathbf{M}$ and $\mathbf{X}$ would all be observed simultaneously prior to the variables in vector $\mathbf{D}$ for the full sample. The staggered addition of veterans into the panel of MCS surveys precludes measurement of vectors $\mathbf{M}$ and $\mathbf{X}$ prior to the measurement of vector $\mathbf{D}$ for the full sample; however, the full sample maximizes statistical power available to analyze detailed variation in combat experiences. The initial set of estimations, as a practical compromise, use the full sample with detailed measures of combat experiences and vector $\mathbf{M}$ observed shortly following possible combat experiences but prior to possible recent homelessness. Vector $\mathbf{X}$, captured at the same time as vector $\mathbf{M}$, captures only characteristics, specially gender, age, race, and childhood experience variables, unaffected by combat experiences. The secondary set of estimations use a sub-sample where vector $\mathbf{M}$ and a

more detailed vector **X** are captured prior to vector **D** and any combat exposure, but the reduction of available statistical power in the sub-sample dictates estimations with only the primary homelessness measure and a single binary combat exposure measure. Secondary estimations of equation 5.1 with and without vector **X** help assess the robustness of initial estimates, the validity of the conditional random assignments assumption, and variation in estimates with pre-deployment characteristics.

Table 5.1 describes variables in vectors **D**, **M**, and **X** for the full sample in column 1 and sub-sample in column 2. Childhood experience variables are only observed at the 2014-2016 survey cycle for both samples. All other variables for the full sample and variables in vector **D** for the sub-sample are observed at the 2011-2013 survey cycle, while variables in vectors **M** and **X** for the sub-sample are observed at the 2007-2008 survey cycle. Table 5.1 Panel A describes variables in vector **D**. Location assignments capturing combat experiences enter into vector **D** at one of two levels. At a broader level, the two possible location categories are overseas service inside Iraq or Afghanistan and service outside Iraq or Afghanistan. Since the majority of GWOT deployments fall within a combat zone and combat zone service data is unavailable, service inside Iraq or Afghanistan proxies as service in a war environment. For the full sample, veterans serve inside Iraq or Afghanistan prior to their 2011-2013 survey date 63 percent of the time. At a more refined level, the three possible location categories are no combat exposure, single combat exposure, and multiple combat exposure. Combat exposure is determined by a veteran indicating personal exposure to witnessing a person's death due to war, disaster, or tragic event at any time prior to their 2011-2013 survey date. The measure is cumulative and includes responses from prior surveys when available. A binary variable indicating another tragic loss, defined by the death or serious illness of a loved one or family member, prior to their 2011-2013 survey date is

included in all models with the combat exposure measure to address misclassification concerns. In the full sample, veterans experience a single combat exposure prior to their 2011-2013 survey date 12 percent of the time and more than one combat exposure prior to their 2011-2013 survey date 30 percent of the time. Additionally, vector **D** includes variables for time deployed and disabilities. Table 5.1 Panel B describes variables in the military vector **M**. The variables include an individual's service entry, years of service, rank, branch, component, and military occupation at the 2011-2013 survey. Table 5.1 Panel C describes individual and family background variables in vector **X** at the 2011-2013 survey. Variable categories included only in the secondary estimations with subsample are marked with a double asterisk.

Table 5.1 Description of Variables in Vectors **D**, **M**, and **X**

		(1)		(2)	
Variable	Description	Mean	SD	Mean	SD
Panel A: Vector D					
Service in war environment					
<i>Iraq or Afghanistan</i>	Equal to 1 if served in Iraq or Afghanistan prior to 2011-2013 survey date, 0 otherwise	0.63	0.48	0.57	0.49
Combat Exposure					
<i>Single</i>	Reference group is no exposure Equal to 1 if reported witnessing death one time due to war, disaster or other tragic event prior to 2011-2013 survey date, 0 otherwise.*	0.12	0.33	0.04	0.19
<i>Multiple</i>	Equal to 1 if reported witnessing death more than one time due to war, disaster or other tragic event prior to 2011-2013 survey date, 0 otherwise.*	0.30	0.46	0.05	0.22
Deployed time	Reference group is only deployed after 2011-2013 survey date				
<i>1-179 days</i>	Equal to 1 if deployed 1-179 days between September 2001 and 2011-2013 survey date, 0 otherwise	0.24	0.43	0.30	0.46
<i>180-364 days</i>	Equal to 1 if deployed 180-364 days between September 2001 and 2011-2013 survey date, 0 otherwise	0.38	0.49	0.37	0.48
<i>>364 days</i>	Equal to 1 if deployed 365 days or more between September 2001 and 2011-2013 survey date, 0 otherwise	0.32	0.47	0.29	0.45
Other related					
<i>Disabling illness/injury</i>	Equal to 1 if reported disabling illness or injury prior to 2011-2013 survey date, 0 otherwise	0.13	0.34	0.11	0.32
<i>Other tragic loss</i>	Equal to 1 if reported the death or serious illness of a family member or loved one prior to 2011-2013 survey date, 0 otherwise	0.76	0.43	0.79	0.40
Panel B: Vector M					
Service Entry	Reference group is <i>Initial service in 2001 or earlier</i>				
<i>Post 2001 Entry</i>	Equal to 1 if initial service in 2002 or later, 0 otherwise	0.57	0.49	0.44	0.50
Years of Service	Reference group is <i>Less than 7 years of military service</i>				
<i>7-12 years</i>	Equal to 1 if years of military service ≥ 7 and < 13 , 0 otherwise	0.29	0.46	0.13	0.34
<i>13-18 years</i>	Equal to 1 if years of military service ≥ 13 and < 19 , 0 otherwise	0.09	0.29	0.13	0.34
<i>19 or more years</i>	Equal to 1 if years of military service ≥ 19 , 0 otherwise	0.26	0.44	0.25	0.43
Rank	Reference group is <i>Enlisted</i>				
<i>Officer</i>	Equal to 1 if officer rank either W1 or O1 or higher, 0 otherwise	0.29	0.45	0.29	0.45
Branch of Service	Reference group is service in the <i>Army</i>				
<i>Navy</i>	Equal to 1 if in the Navy or Coast Guard, 0 otherwise	0.15	0.36	0.17	0.38

Variable	Description	(1)		(2)	
		Mean	SD	Mean	SD
<i>Air Force</i>	Equal to 1 if in the Air Force, 0 otherwise	0.30	0.46	0.38	0.49
<i>Marine Corps</i>	Equal to 1 if in the Marine Corps, 0 otherwise	0.08	0.26	0.07	0.25
Component	Reference group is <i>Active Duty</i>				
<i>Reserve or National Guard</i>	Equal to 1 if in Reserve or National Guard, 0 otherwise	0.28	0.45	0.33	0.47
<i>Separated</i>	Equal to 1 if separated, retired, or unknown component, 0 otherwise	0.25	0.43	0.11	0.31
Occupation	Reference group is <i>Combat specialist</i>				
<i>Electrical Repair</i>	Equal to 1 if electrical repair occupation, 0 otherwise	0.09	0.28	0.11	0.31
<i>Comm/Intel</i>	Equal to 1 if communications/intelligence occupation, 0 otherwise	0.10	0.30	0.10	0.30
<i>Health care</i>	Equal to 1 if health care occupation, 0 otherwise	0.10	0.31	0.07	0.26
<i>Other technical</i>	Equal to 1 if other technical or specialty occupation, 0 otherwise	0.03	0.17	0.03	0.17
<i>Functional support</i>	Equal to 1 if functional support occupation, 0 otherwise	0.18	0.38	0.21	0.40
<i>Equipment Repair</i>	Equal to 1 if equipment repair occupation, 0 otherwise	0.13	0.33	0.15	0.36
<i>Craft workers</i>	Equal to 1 if craft worker occupation, 0 otherwise	0.03	0.17	0.03	0.18
<i>Service and Supply</i>	Equal to 1 if service and supply occupation, 0 otherwise	0.12	0.32	0.09	0.29
<i>Other</i>	Equal to 1 if other occupation, 0 otherwise	0.03	0.18	0.04	0.20
Panel C: Vector X					
<i>Female</i>	Equal to 1 if female gender, 0 otherwise	0.25	0.43	0.30	0.46
<i>Age</i>	Age in years	35.29	9.67	33.49	9.48
<i>Age²</i>	Age in years x Age in years survey	1339.10	768.80	1211.11	701.49
Race & Ethnicity	Reference group is <i>White, Non-Hispanic</i>				
<i>Black</i>	Equal to 1 if black race and non-Hispanic ethnicity, 0 otherwise	0.08	0.28	0.10	0.29
<i>Other</i>	Equal to 1 if other race and non-Hispanic ethnicity, 0 otherwise	0.10	0.30	0.10	0.29
<i>Hispanic</i>	Equal to 1 if Hispanic ethnicity, 0	0.07	0.26	0.07	0.25
Childhood Neglect	Equal to 1 if respondent indicated grown-ups did not take care of them in the way that they should before the age of 18, 0 otherwise. Examples of neglect in question include respondent not getting enough food, receiving medical care when sick, and having a safe place to stay.	0.10	0.29	0.08	0.27
<i>Verbal abuse</i>	Equal to 1 if respondent indicated grown-ups made them feel scared or really bad by saying mean things to them before the age of 18, 0 otherwise	0.24	0.43	0.22	0.42
<i>Physical abuse</i>	Equal to 1 if respondent indicated grown-ups hit (not including spanking on the bottom), beat, kicked, or physically hurt them before the age of 18, 0 otherwise	0.32	0.46	0.29	0.45
<i>Sexual abuse</i>	Equal to 1 if respondent indicated grown-ups touched private parts when they	0.10	0.30	0.10	0.30

Variable	Description	(1)		(2)	
		Mean	SD	Mean	SD
	shouldn't have, made them touch their private parts, or forced them to have sex, 0 otherwise				
Financial**					
<i>Some distress</i>	Equal to 1 if reported some stress from financial problems, 0 otherwise	0.32	0.47	0.28	0.45
<i>High distress</i>	Equal to 1 if reported a lot of stress from financial problems, 0 otherwise	0.11	0.31	0.06	0.24
Education**	Reference group is <i>High School or less</i>				
<i>Some College</i>	Equal to 1 if only some college education, 0 otherwise	0.48	0.50	0.49	0.50
<i>College Degree</i>	Equal to 1 if Bachelor's degree or higher, 0 otherwise	0.43	0.50	0.40	0.49
Family Structure**					
<i>Dependents</i>	Equal to number of dependents in military record.	1.56	1.52	1.47	1.51
	Last known value used if value missing at prior survey.				
<i>Recent divorce</i>	Equal to 1 if divorced or separated in past 3 years (or ever if baseline survey), 0 otherwise	0.13	0.34	0.10	0.30
Health**					
<i>PCS</i>	Physical health component score****	52.90	7.81	54.56	6.35
<i>MCS</i>	Mental health component score****	50.11	10.56	51.84	8.61
<i>Smoking</i>	Equal to 1 if past year smoked cigarettes (ever smoked 100 cigarettes if baseline survey), 0 otherwise	0.26	0.44	0.25	0.43
<i>Heavy drinking</i>	Equal to 1 if 15 (8) drinks or more during a typical week for men (women), 0 otherwise	0.08	0.26	0.08	0.27
Observations		50,522		20,102	

SD=Standard Deviation. Table displays unweighted means of variables generated using survey responses and DMDC data. Description of dummy variables for missing family structure, health, health behaviors, and childhood variable responses not displayed.

*- In cases where a veteran's primary indication of combat exposure is missing in a survey, combat exposure is determined by a veteran indicating on 2007-2008 survey and later surveys seeing Americans who were seriously injured or killed during deployment or, if unavailable, the previous level of combat exposure. For sub-sample, single and multiple categories are combined into binary measure for regressions.

** - Variables only included in secondary estimations with subsamples.

*** - The MCS and PCS are standard health instruments commonly used in veteran studies. Higher scores imply better health. The scores are derived from 36 five-choice ordinal scale questions in eight health domains. The eight health domains are: physical functioning, role limitations due to physical problems, bodily pain, general health perceptions, energy/vitality, social functioning, role limitations due to emotional problems, and mental health. The transformation of the questions into the uncorrelated component summary scales is accomplished using weights derived from a national probability sample of the US population, and the scales are standardized so the MCS and PCS have a direct interpretation to a US population mean of 50 and standard deviation of 10 (Hays, Sherbourne, and Mazel 1993; Kazis et al. 2004)

Estimates of the Effects of Combat Experiences on Homelessness

Estimated marginal effects of service in a war environment on homelessness as described in equation 5.1 are not significantly different than zero and not displayed. Table 5.2 presents the marginal effects of different combat experience measures on homelessness. Table 5.3 examines variation in the marginal effect of combat exposure over time. Table 5.4 presents estimations using the sub-sample containing more detailed background characteristics, and graphical analyses examine predicted variation in the marginal effect of combat exposure on homelessness with background characteristics.

Deployed Veterans Sample

Table 5.2 results reveal consistent detrimental effects of combat exposure on the probability of later experiencing homelessness. The results highlight value added by specific combat exposure measures as the service in a war environment measure masks important heterogeneity below country level. Estimates in Table 5.2 column 1 are from the model with the dependent binary variable of homelessness. Table 5.2 column 1 indicates a single combat exposure increases the probability of homelessness by about 0.4 percentage points and multiple combat exposures increase the probability of homelessness by about 0.6 percentage points. The weighted average effect of combat exposure, conditional on the share of single and multiple exposures observed in the sample, indicates an expected 0.5 percentage point increase in the probability of homelessness. Estimates are substantial relative to the 1.5 percent mean level of homelessness. Estimates in Table 5.2 columns 2, 3, and 4 from the multinomial model correspond to marginal effects on the respective overall probabilities of no homeless episode, a short homeless episode of 3 months or less, and a long homeless episode of more than 3 months. Less than one percent of the sample observations indicate a homeless episode of a specific

duration definitively occurring after possible combat exposure, but estimations still reveal significant deleterious effects of combat exposure on the probabilities of later experiencing a homeless episode, regardless of duration.

Additionally, Table 5.2 includes estimated marginal effects of other deployment related factors on the probability of homelessness. The results across all columns suggest deployed time is not associated with homelessness, but the results indicate veterans reporting disabilities are at an increased risk of homelessness. The influence of other tragic losses involving a veteran's family or loved ones on homelessness appears similar to influence of combat exposure on homelessness, and the results suggest the inclusion of other tragic losses in the model helps reduce possible conflating of estimates of combat and non-combat traumatic experiences that could be captured by the defined combat exposure variable. As the primary interest is in the consequences of combat experiences, the influence of other background variables on homelessness is described in Appendix A, Table A5.1.

Table 5.2 Marginal Effects of Combat Experiences on Homelessness

	(1) Pr(Y=Homeless) Effect SE		(2) Pr(Y=None) Effect SE		(3) Pr(Y=Short) Effect SE		(4) Pr(Y=Long) Effect SE	
Combat Exposure								
<i>Single</i>	0.0040	0.0018	-0.0021	0.0009	0.0005	0.0006	0.0015	0.0006
<i>Multiple</i>	0.0057	0.0014	-0.0025	0.0007	0.0013	0.0005	0.0012	0.0004
<i>Weighted average*</i>	0.0050	0.0011	-0.0022	0.0005	0.0010	0.0004	0.0012	0.0003
Deployed time								
<i>1-179 days</i>	0.0046	0.0033	-0.0020	0.0016	0.0014	0.0013	0.0005	0.0009
<i>180-364 days</i>	0.0035	0.0029	-0.0017	0.0014	0.0013	0.0011	0.0004	0.0008
<i>>364 days</i>	0.0019	0.0029	-0.0012	0.0014	0.0010	0.0011	0.0002	0.0008
<i>Weighted average*</i>	0.0028	0.0021	-0.0013	0.0009	0.0009	0.0007	0.0003	0.0006
<i>Disabling illness/injury</i>	0.0070	0.0017	-0.0033	0.0008	0.0015	0.0006	0.0018	0.0005
<i>Other tragic loss</i>	0.0022	0.0011	-0.0008	0.0005	0.0001	0.0004	0.0007	0.0003
Observations	50,522				50,187			
Pseudo-R ²	0.89				0.95			

*- weighted average of unspecified switch from reference category computed using sample shares of each category

Column 1 displays GME marginal effects of variables on the primary binary measure of homelessness. Columns 2-4 display GME marginal effects of variables on the alternate multinomial measure of homelessness.

SE=Standard Error. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean. All columns include military control variables in Table 5.1 Panel B, and variables for age, gender, race, ethnicity, and adverse childhood experiences in Table 5.1 Panel C.

Table 5.2 does not distinguish between recent and past combat exposure, and Table 5.3 addresses this limitation. Table 5.3 indicates combat exposure in the 3 years prior to a veteran's 2011-2013 survey date has deleterious effects on the probability of later experiencing homelessness. Table 5.3 suggests earlier combat exposure may also be deleterious to veterans, but the estimates are not precise and require caution in interpretation.

Table 5.3 Marginal Effects of Combat Exposure over Time on Homelessness

	(1) Pr(Y=Homeless)		(2) Pr(Y=None)		(3) Pr(Y=Short)		(4) Pr(Y=Long)	
	Effect	SE	Effect	SE	Effect	SE	Effect	SE
(≤ 3 years*)								
Single	0.0069	0.0023	-0.0030	0.0010	0.0011	0.0007	0.0019	0.0007
Multiple	0.0068	0.0018	-0.0027	0.0008	0.0014	0.0006	0.0014	0.0005
(> 3 years*)								
Single	-0.0004	0.0018	-0.0008	0.0009	0.0003	0.0007	0.0005	0.0005
Multiple	0.0024	0.0015	-0.0012	0.0007	0.0010	0.0006	0.0002	0.0004
Observations	50,110				49,777			
Pseudo-R ²	0.89				0.95			

* from 2011-2013 survey date

Column 1 displays GME marginal effects of variables on the primary binary measure of homelessness. Columns 2-4 display GME marginal effects of variables on the alternate multinomial measure of homelessness.

SE=Standard Error. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean. All columns include control variables for deployed time, disabling illness or injury, other tragic loss, military control variables in Table 5.1 Panel B, and variables for age, gender, race, ethnicity, and adverse childhood experiences in Table 5.1 Panel C

Deployed Veterans Sample with Detailed Background Variables

Table 5.4 column 1 displays the marginal effects of combat exposure on homelessness with only military background variables, and Table 5.4 column 2 displays the marginal effects of combat exposure on homelessness with military and detailed non-military background variables. The sample in Panel A has no reported combat exposure prior to the 2007-2008 survey cycle, and the sample in Panel B is further restricted to only those who do not report childhood neglect, a proxy for homelessness prior to military service. Neither the inclusion of background variables nor the exclusion of those with childhood neglect in estimations influences the nature of the results. In addition to providing further support for the conditional random assignments assumption, estimates consistently suggest combat exposure increases the probability of later experiencing homelessness.

Table 5.4 Marginal Effects of Combat Exposure on Homelessness for Sample with Detailed Background Variables

	(1)		(2)	
	Military Only		Military + Civilian	
	Pr(Y=Homeless)		Pr(Y=Homeless)	
	Effect	SE	Effect	SE
Panel A: No prior exposure				
<i>Combat Exposure</i>	0.0076	0.0031	0.0071	0.0031
Observations	20,102		20,102	
Pseudo-R ²	0.91		0.91	
Panel B: No prior exposure or childhood neglect				
<i>Combat Exposure</i>	0.0067	0.0032	0.0058	0.0030
Observations	17,983		17,983	
Pseudo-R ²	0.91		0.92	

Panel A and B sample includes only veterans with no prior combat exposure at 2007-2008 survey cycle. Panel B sample exclude veterans with childhood neglect. Column 1 displays GME marginal effects for model with variables for deployed time, disabling illness or injury, and other tragic loss in Table 5.1 Panel A and variables for pre-deployment military characteristics defined in Table 5.1 Panel B and observed at 2007-2008 survey cycle. Column 2 displays GME marginal effects for model with all variables included in Column 1 and all variables defined in Table 5.1 Panel C and observed at 2007-2008 survey cycle. SE=Standard Error. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean.

While the marginal effects computed with all other variables set to sample means provide insight at one important point, estimates with a range of values for background characteristics help us understand how the predicted effect of combat exposure on homelessness changes. Figures 5.2 and 5.3, generated using parameters estimated for the Table 5.4 Panel A model specification with all background variables, illustrate variation in the effects of combat exposure among veterans of different ages and health. The predicted effect of combat exposure on homelessness for veterans in their 20s is about 0.75 percentage-points and exhibits little variation; however, the predicted effect of combat exposure on homelessness drops about 0.5 percentage-points between the age of 30 and 60. Figure 5.3 reveals veterans with poorer pre-deployment self-reported health scores, especially mental health, appear more vulnerable to the effects of combat exposure on homelessness. A 10-point, or one standard deviation for the US

population, decline in either the mental or physical component score from the US population mean score of 50 translates to about a 20 percent increase in the marginal effect of combat exposure on homelessness. The findings suggest increased health capital, a non-monetary resource, can lessen the impact of traumatic exposure on homelessness.

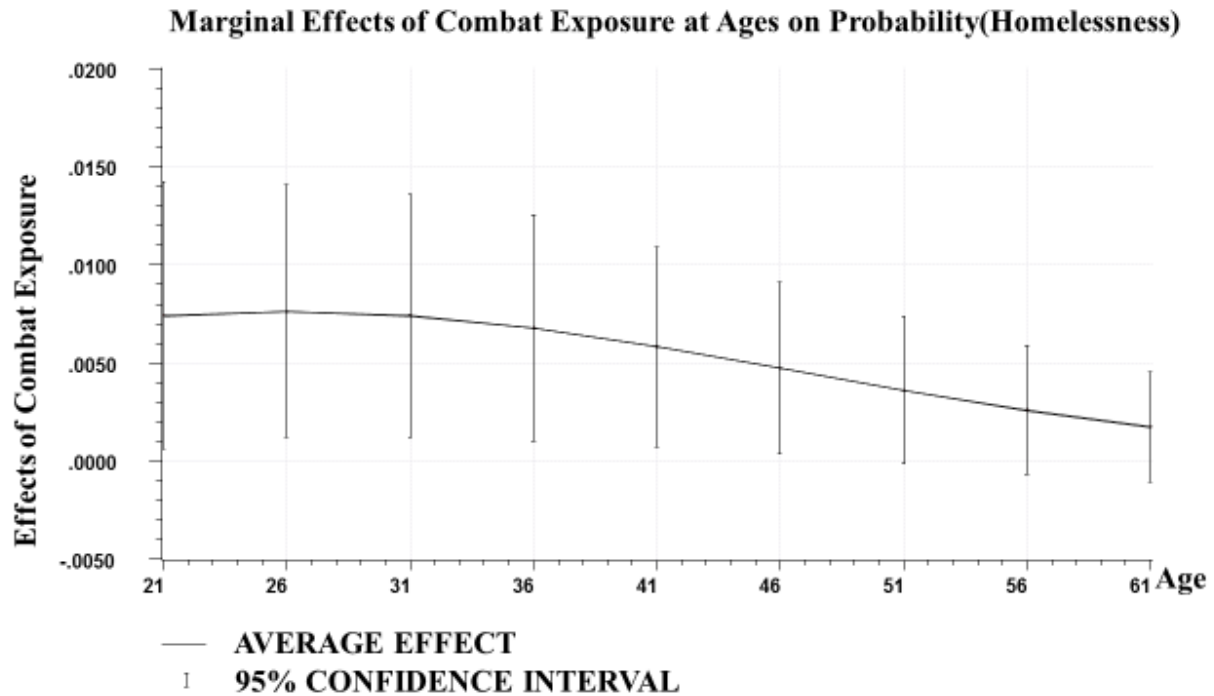


Figure 5.2 Marginal Effects of Combat Exposure at Ages on Probability (Homelessness)
 GME marginal effects for categorical values of combat exposure and rank computed by setting all observations to category value and comparing to respective base value with age set to values 21, 26,...,56,61 and all other variables set to sample means. Model includes variables for deployed time, disabling illness or injury, and other tragic loss in Table 5.1 Panel A. Model includes variables for pre-deployment military characteristics defined in Table 5.1 Panel B and observed at 2007-2008 survey cycle. Model includes variables all variables defined in Table 5.1 Panel C and observed at 2007-2008 survey cycle.

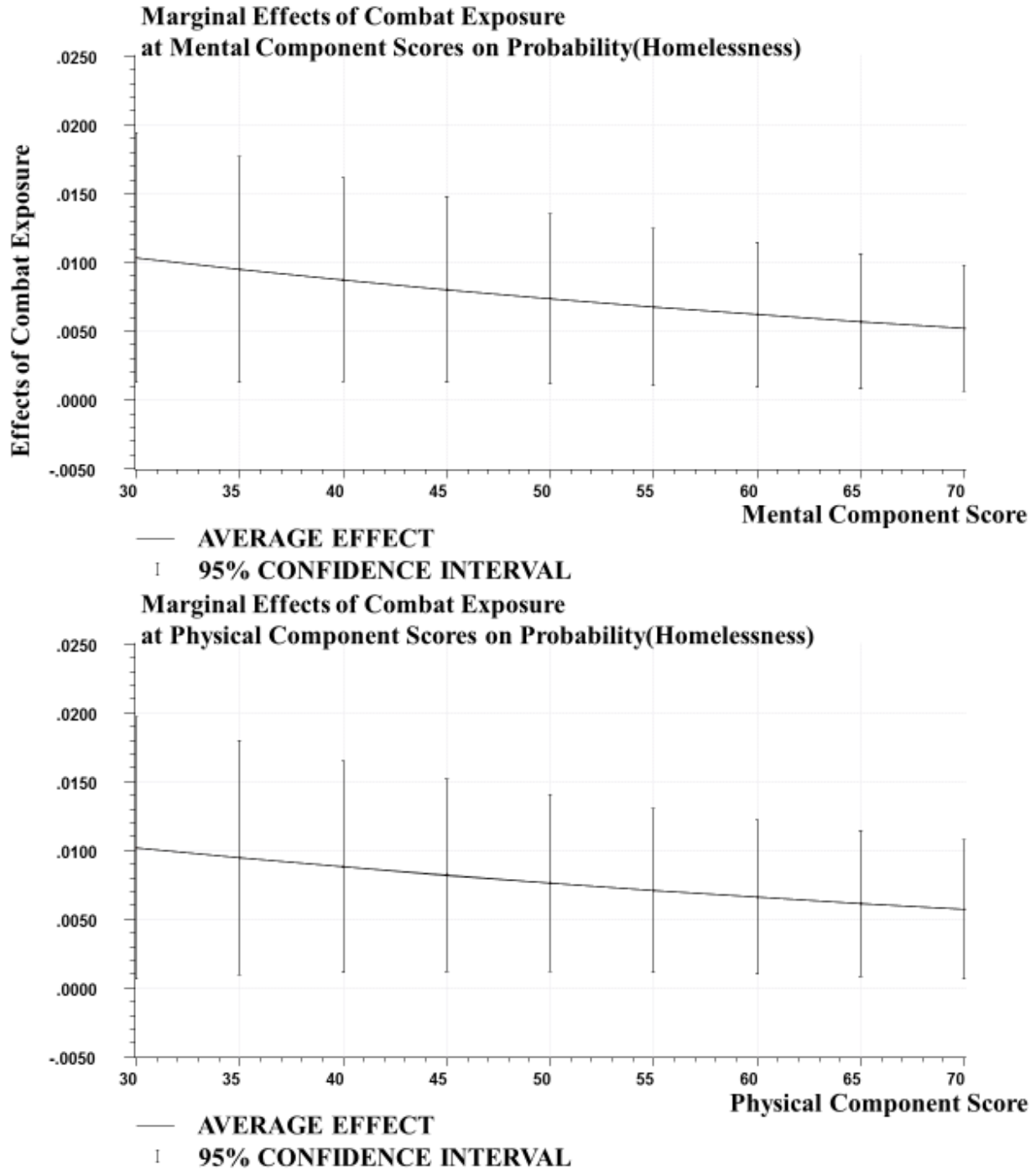


Figure 5.3 Marginal Effects of Combat Exposure at Health Scores on Probability (Homelessness)
 GME marginal effects for categorical values of combat exposure and rank computed by setting all observations to category value and comparing to respective base value with age set to values 30, 35,..., 65, 70 and all other variables set to sample means. Model includes variables for deployed time, disabling illness or injury, and other tragic loss in Table 5.1 Panel A. Model includes variables for pre-deployment military characteristics defined in Table 5.1 Panel B and observed at 2007-2008 survey cycle. Model includes variables all variables defined in Table 5.1 Panel C and observed at 2007-2008 survey cycle.

Summary of Results and Discussion

Though homelessness among recently deployed veterans is a growing concern, there has been no previous comprehensive examination of the relationship between combat exposure and later homelessness among recently deployed veterans. Studies of veterans from previous eras looking to military experiences as risk factors for homelessness have not yielded clear conclusions (Fullerton and Ursano 2009). The results of this study consistently indicate that deployed veterans exposed to combat are at increased risk of homelessness compared to deployed veterans not exposed to combat. The results indicate, on average, the probability of homelessness increases 0.40 percentage points (27 percent relative to the mean probability) following a single combat exposure and increases 0.57 percentage points (38 percent relative to the mean probability) following multiple combat exposures. Considering reported combat exposure rates in the study and 2.1 million veterans deploying prior to 2011, the results suggest combat exposure may have contributed to around 4,600 veterans experiencing homelessness between 2011 and 2016. Assuming the 9 month average reported homeless episode duration in the study and the \$43.32 maximum Fiscal Year 2014 US government reimbursable per diem available to organizations caring for a homeless veteran as capturing per day public costs (Perl 2015), the results suggest a substantial public cost estimate of \$54 million. Still, this estimate does not consider private costs, long-term costs, or capture effects of homelessness prior to 2011 resulting from combat exposure.

The current study stands out among other homelessness studies for other reasons as well. Simulation results help identify policy relevant characteristics that may be targeted before a veteran is sent into harm's way. The results point towards veterans with poorer pre-deployment mental or physical health and veterans under age 30 as being less resilient to the effects of combat exposure on financial problems. Additionally, unlike previous studies of veteran

homelessness using VA administrative data (Metraux et al. 2013; Perl 2015), the current study includes veterans ineligible (due to active status or an unfavorable military separation) and electing not to use VA services. The current study also conducts estimations showing combat exposure contributes to both short and long homeless episodes. The findings of the study are robust to the inclusion of deployed time, disability or illness, and pre-deployment adverse experiences, including childhood neglect. The current study provides a more comprehensive picture of homelessness among recently deployed veterans.

CHAPTER 6

SUMMARY AND IMPLICATIONS

Although consequences of military experiences are of persistent economic interest, previous scholars have not addressed whether (i) service in war environments and (ii) exposure to traumatic events affect three well-being aspects – sexually transmitted diseases (STDs), financial problems, and homelessness – in surviving deployed veterans. This dissertation estimates the marginal effects of combat experiences on the probabilities of acquiring an STD, developing a major financial problem, and experiencing homelessness. Information theoretic methods reduce the sensitivity of estimates to uncertainty surrounding small samples, infrequently observed outcomes, and highly correlated covariates. Estimates exploit plausibly exogenous variation in location assignments among deployed veterans to reduce bias from potential non-random selection into combat experiences.

Table 6.1 summarizes the results of preferred model specifications, which include control variables for both military and civilian background characteristics. Table 6.1 column 2 shows estimates for service in a war environment, the broader level location assignment, do not explain individual changes in well-being. However, estimates in column 3 for the more refined location assignment indicate links between a deployed veteran's exposure to traumatic events and increases in the probability of acquiring an STD, developing a financial problem, and later experiencing homelessness. Harmful effects of combat exposure also increase with multiple exposures. The changes in STDs, financial problems, and homelessness may not be discernable through conventional labor market measures, but the changes capture extreme declines in well-being. Furthermore, the fact observed links between combat exposure and extreme declines in well-being remain after accounting for physical harms highlights the importance of considering potential individual changes in multiple domains following a traumatic exposure. The results

suggest that funding to address care for STDs, financial problems, and homelessness should be considered of particular importance during times of high deployment rates with combat exposure.

Table 6.1 Empirical Summary of Combat Experiences on Well-being Aspects

Well-being aspect	(1) Sample		(2) War Environment		(3) Combat Exposure		(3) Multiple Exposure	
	Mean	#	Effect	SE	Effect	SE	Effect	SE
STDs								
<i>Past year STD</i>	0.054	484	-0.000	0.027	0.054	0.026	N/A	N/A
Financial Problems								
<i>Major problem & Distress</i>	0.021	131,036	0.0010	0.0011	0.0044	0.0015	0.0090	0.0013
Homelessness								
<i>Homeless</i>	0.015	50,522	0.0008	0.0013	0.0040	0.0018	0.0057	0.0014

Effect = GME Marginal Effects, SE = Standard Error. Estimates for STDs from models in Table 3.5. Estimates for financial problems from models in Tables 4.5-4.6. Estimates for homelessness from models in Tables 5.2-5.3. See referenced tables for full multinomial model descriptions.

While the dissertation focuses on identifying average effects of combat experiences on understudied aspects of veteran well-being, estimations also explore potential mechanisms through which the combat exposure and STD relationship may operate. Regressions provide suggestive evidence that substance use and relationship stability, captured by the number of recent sexual partners, serve as pathways from combat exposure to STDs. The results show combat-related input changes in the production of the sexual health. Though input measures needed to test either allocative or productive efficiency changes are unavailable, average effects of combat exposure on all well-being aspects examined by the dissertation are consistent with the view that traumatic events reduce the efficiency of production. Moreover, the exploration of mechanisms identifies areas for intervention that may prevent further declines in well-being following combat exposure.

The dissertation also examines variation in the effects of combat exposure for veterans with different background characteristics. Results indicate veterans with poorer pre-deployment health and veterans in enlisted ranks are more vulnerable to the effects of combat exposure on financial problems. Results also indicate younger veterans with poorer pre-deployment health are more vulnerable to the effects of combat exposure on homelessness. The pattern of results

suggests investments in health capital may mitigate harmful effects of combat exposure on economic well-being. Similarly, policy makers may want to consider more stringent targeting of health in the pre-deployment selection process.

Estimations also find time spent deployed positively associated with some aspects of well-being. While increases in deployed time are not associated with the probability of homelessness, the most infrequent outcome examined in the dissertation, increases in deployed time are associated with decreases in the probability of acquiring an STD and the probability of developing a financial problem. One possible explanation for the associations is the increased pay linked to a veteran's deployed time by current policies seems likely to help ease deployment related stress. Other possible explanations exist. Human capital growth may result from military policies limiting risky health behaviors or granting increased responsibility for lethal and other pressing decisions. Additionally, the geographic isolation of overseas military bases from US markets limit consumption opportunities. Data is not available to determine what factors associated with deployed time are driving the positive changes observed in well-being; however, if pay policies are the driving force, then possible welfare gains exist from changing pay policies. As previous research has found geographic variation in the risk of combat exposure is not correlated with combat related-deployment compensation for recent overseas operations (Pleeter et al. 2011), the connection of combat-related deployment compensation to combat exposure instead of time deployed could be beneficial. Even with additional evidence in support of increased pay, such a policy still faces challenges. A policy linking monetary benefits to actual exposures may incentivize undesired risk taking, while a policy linking monetary benefits to past exposures at a location may not accurately capture actual exposure risk and may provide unfair compensation.

Though results identify how pre-deployment background characteristics and specific deployment related experiences affect individual adaption to adversity, the results are still limited and motivate future research. Two areas stand out. First, mediation analysis was limited because data lack information on the temporal sequence of potential mechanisms and outcomes following combat exposure. More frequent or temporally detailed data collection could enable future research necessary to establish pathways from combat exposure to declines in well-being. The identification of pathways would benefit post-deployment screening and care policies. Second, the new evidence on health capital improving resiliency to the effects of combat exposure was limited. The results do not explain contributions of specific pre-deployment mental or physical health factors. Estimations rely upon self-reported health measures and lack data on veteran medical treatment. Further research with more detailed health data would benefit pre-deployment screening and care policies and improve the resiliency of veterans in future combat operations.

APPENDIX A

SUPPLEMENTARY MATERIAL

Appendix A includes tables and figures to supplement analysis in Chapters 3, 4, and 5.

Table A3.1 includes a description of occupation variables for male veterans in the NLSAAH. The standard 6-digit occupation codes are aggregated at the intermediate (2-digit) level with exception of military specific occupations, which are divided into categories that are more detailed.

Table A3.1 Description of Occupation Variables

Variable	Description	Deployed Overseas (N=485)	Combat Zone (N=370)
<i>Military Aviation</i>	Equal to 1 if respondent described (i) current or most recent job in military aircrew or aviation category (ii) if current or most recent job code not a military specific occupation, then equal to 1 if respondent described first job in military aircrew or aviation category, 0 otherwise	0.027 (0.16)	0.030 (0.17)
<i>Military Tactical Specialist</i>	Equal to 1 if respondent described (i) current or most recent job in military tactical specialist or related category (ii) if current or most recent job code not a military specific occupation, then equal to 1 if respondent described first job in military aircrew or aviation category, 0 otherwise	0.037 (0.19)	0.041 (0.20)
<i>Financial and Management</i>	Equal to 1 if respondent described current or most recent job in financial or management category and first job not coded as military specific, 0 otherwise	0.060 (0.24)	0.057 (0.23)
<i>Computer, Engineering, and Science</i>	Equal to 1 if respondent described current or most recent job in computer, engineering, and science category and first job not coded as military specific, 0 otherwise	0.060 (0.24)	0.060 (0.24)
<i>Healthcare</i>	Equal to 1 if respondent described current or most recent job in healthcare practitioners and technical occupations category and first job not coded as military specific, 0 otherwise	0.025 (0.16)	0.019 (0.14)
<i>Education, Legal, Arts and Media</i>	Equal to 1 if respondent described current or most recent job in education, legal, community service, arts and media category and first job not coded as military specific, 0 otherwise	0.027 (0.16)	0.030 (0.17)
<i>Contracting</i>	Equal to 1 if respondent described current or most recent job in sales and related category and first job not coded as military specific, 0 otherwise	0.103 (0.30)	0.114 (0.32)
<i>Administrative Support</i>	Equal to 1 if respondent described current or most recent job in office and administrative support category and first job not coded as military specific, 0 otherwise	0.043 (0.20)	0.051 (0.22)
<i>Natural Resources</i>	Equal to 1 if respondent described current or most recent job in natural resources category and first job not coded as military specific, 0 otherwise	0.012 (0.11)	0.014 (0.12)
<i>Construction</i>	Equal to 1 if respondent described current or most recent job in construction category and first job not coded as military specific, 0 otherwise	0.080 (0.27)	0.062 (0.24)
<i>Maintenance</i>	Equal to 1 if respondent described current or most recent job in installation, maintenance and repair category and first job not coded as military specific, 0 otherwise	0.087 (0.28)	0.097 (0.30)
<i>Production</i>	Equal to 1 if respondent described current or most recent job in production category and first job not coded as military specific, 0 otherwise	0.089 (0.28)	0.076 (0.26)
<i>Transportation and Logistics</i>	Equal to 1 if respondent described current or most recent job in transportation and material moving category and first job not coded as military specific, 0 otherwise	0.072 (0.26)	0.068 (0.25)
<i>Other and unknown</i>		0.080	0.095

Variable	Description	Deployed Overseas (N=485)	Combat Zone (N=370)
	Equal to 1 if respondent described current or most recent job in other or unknown category and first job not coded as military specific, 0 otherwise	(0.27)	(0.29)

Standard deviations in parentheses. Unweighted means generated using Waves I and IV of NLSAHH.

Table A4.1 displays the influence of individual military, individual non-military, and economic variables on financial decline. Several military variables influence financial decline. Military service for more than 6 years, in the officer ranks, in the Air Force, and in the Active Duty component are each associated with increases in the no probability of financial decline. The time of military service entry is not associated with financial decline, and variation in financial decline explained by occupational classifications is relatively limited.

The results suggest several individual non-military variables also influence financial decline. Hispanic ethnicity, higher numbers of dependents, divorce in the past 3 years, smoking, heavy drinking, and adverse childhood experiences are associated with decreases in the probability of no financial decline. Higher educational attainment, higher physical health scores (PCS), and higher mental health scores (MCS) are associated with increases in the probability of no financial decline. The inclusion of the pre-deployment financial distress variable improves the model accuracy, but the marginal effects require caution in interpretation as veterans with pre-deployment financial distress can only move one (rather than two for veterans without pre-deployment financial distress) level higher on the financial distress scale. As the age variable enters the model non-linearly, the displayed marginal effects at the mean age on financial decline require caution in interpretation.

The model suggests recent economic conditions have greater influence on financial decline than pre-deployment economic conditions. Higher recent GDP growth and higher inflation adjusted military pay growth are associated with increases in the probability of no financial decline. On the other hand, the variation in financial decline explained by pre-deployment GDP growth and inflation adjusted military pay growth is relatively limited. A possible takeaway is that policies increasing military pay (at levels observed in the sample) may

not help prevent veteran financial problems in the long-term and policy makers may want to consider other interventions to prevent veteran financial problems in the long-term.

Table A4.1 Marginal Effects of Background Variables on Financial Problem Development

	(1)		(2)		(3)		(4)	
	Pr(Y=None)		Pr(Y=DO)		Pr(Y=MPO)		Pr(Y=D&MP)	
	Effect	SE	Effect	SE	Effect	SE	Effect	SE
<u>Other Military Variables</u>								
Service Entry								
<i>Post 2001 Entry</i>	0.0035	0.0038	-0.0011	0.0037	-0.0019	-0.0005	-0.0005	0.0010
Years of Service								
<i>7-12 years</i>	0.0151	0.0036	-0.0137	0.0035	-0.0007	-0.0007	-0.0007	0.0010
<i>13-18 years</i>	0.0209	0.0050	-0.0153	0.0048	-0.0022	-0.0033	-0.0033	0.0012
<i>19 or more years</i>	0.0169	0.0058	-0.0093	0.0057	-0.0037	-0.0039	-0.0039	0.0014
Rank								
<i>Officer</i>	0.0674	0.0037	-0.0556	0.0035	-0.0035	-0.0083	-0.0083	0.0010
Branch of Service								
<i>Navy</i>	-0.0063	0.0036	0.0072	0.0034	-0.0006	-0.0004	-0.0004	0.0009
<i>Air Force</i>	0.0566	0.0028	-0.0504	0.0026	-0.0004	-0.0058	-0.0058	0.0007
<i>Marine Corps</i>	-0.0318	0.0051	0.0359	0.0050	-0.0018	-0.0023	-0.0023	0.0011
Component								
<i>Reserve or National Guard</i>	-0.0523	0.0028	0.0407	0.0027	0.0022	0.0094	0.0094	0.0009
<i>Separated</i>	-0.0118	0.0050	0.0107	0.0048	0.0005	0.0006	0.0006	0.0013
Occupational Classification								
<i>Electrical Repair</i>	0.0034	0.0046	-0.0054	0.0044	0.0015	0.0005	0.0005	0.0014
<i>Comm/Intel</i>	0.0054	0.0045	-0.0062	0.0043	-0.0001	0.0008	0.0008	0.0013
<i>Health care</i>	-0.0122	0.0048	0.0117	0.0046	0.0001	0.0005	0.0005	0.0013
<i>Other technical</i>	-0.0149	0.0077	0.0127	0.0073	0.0013	0.0010	0.0010	0.0020
<i>Functional support</i>	0.0093	0.0039	-0.0100	0.0037	0.0003	0.0004	0.0004	0.0011
<i>Equipment Repair</i>	0.0054	0.0042	-0.0074	0.0040	0.0013	0.0008	0.0008	0.0012
<i>Craft workers</i>	0.0016	0.0070	-0.0069	0.0066	0.0016	0.0037	0.0037	0.0020
<i>Service and Supply</i>	-0.0124	0.0045	0.0093	0.0043	0.0006	0.0025	0.0025	0.0013
<i>Other</i>	0.0212	0.0062	-0.0176	0.0059	-0.0008	-0.0028	-0.0028	0.0017
<u>Non-Military Background Variables</u>								
<i>Financial Distress</i>	0.1724	0.0025	-0.1942	0.0023	0.0224	-0.0005	-0.0005	0.0006
<i>Female</i>	-0.0027	0.0030	0.0049	0.0029	-0.0017	-0.0005	-0.0005	0.0008
<i>Age</i>	0.0029	0.0003	-0.0029	0.0003	0.0001	-0.0002	-0.0002	0.0001
Race								
<i>Black Non-Hispanic</i>	-0.0007	0.0041	-0.0059	0.0039	0.0023	0.0043	0.0043	0.0012
<i>Other Non-Hispanic</i>	0.0057	0.0039	-0.0046	0.0037	-0.0007	-0.0004	-0.0004	0.0011
<i>Hispanic</i>	-0.0184	0.0047	0.0156	0.0045	0.0008	0.0020	0.0020	0.0012
Education								
<i>Some College</i>	0.0122	0.0036	-0.0109	0.0035	-0.0003	-0.0010	-0.0010	0.0009
<i>College Degree</i>	0.0262	0.0047	-0.0217	0.0045	-0.0016	-0.0029	-0.0029	0.0012
Family Structure								
<i>Number of Dependents</i>	-0.0121	0.0009	0.0093	0.0009	0.0009	0.0019	0.0019	0.0002
<i>Divorce</i>	-0.0109	0.0036	0.0041	0.0034	0.0026	0.0042	0.0042	0.0010
Health								
<i>PCS</i>	0.0042	0.0002	-0.0038	0.0002	0.0000	-0.0004	-0.0004	0.0000
<i>MCS</i>	0.0055	0.0001	-0.0051	0.0001	0.0000	-0.0005	-0.0005	0.0000
<i>Smoking</i>	-0.0178	0.0027	0.0127	0.0026	0.0015	0.0035	0.0035	0.0007
<i>Heavy Drinking</i>	-0.0191	0.0047	0.0198	0.0046	-0.0016	0.0009	0.0009	0.0011
Childhood Experiences								

	(1) Pr(Y=None)		(2) Pr(Y=DO)		(3) Pr(Y=MPO)		(4) Pr(Y=D&MP)	
	Effect	SE	Effect	SE	Effect	SE	Effect	SE
<i>Neglect</i>	-0.0099	0.0050	0.0045	0.0047	0.0025	0.0029	0.0029	0.0012
<i>Verbal Abuse</i>	-0.0318	0.0038	0.0254	0.0036	0.0008	0.0056	0.0056	0.0011
<i>Physical Abuse</i>	-0.0213	0.0032	0.0183	0.0031	0.0009	0.0021	0.0021	0.0009
<i>Sexual Abuse</i>	-0.0331	0.0047	0.0279	0.0046	0.0018	0.0034	0.0034	0.0012
Macroeconomic								
<i>GDP growth</i>	0.0220	0.0016	-0.0181	0.0015	-0.0004	-0.0036	-0.0036	0.0004
<i>Lag GDP growth</i>	0.0020	0.0010	-0.0004	0.0009	-0.0008	-0.0007	-0.0007	0.0003
<i>Military pay growth</i>	0.0219	0.0018	-0.0178	0.0018	-0.0003	-0.0038	-0.0038	0.0005
<i>Lag Military pay growth</i>	-0.0016	0.0016	0.0003	0.0015	0.0002	0.0012	0.0012	0.0005
Observations					131,036			
Pseudo-R ²					0.55			

DO=Distress Only, **MPO**=Major Problem Only, **D&MP**=Distress & Major Problem

Effect = GME marginal effect. SE= Standard error. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean. All columns include deployment related variables in Table 4.5 and dummy variables for missing values of family structure, health, health behaviors, and childhood experiences.

Figure A4.1 presents the marginal effects of combat exposure on the probability of a new major financial problems and distress for different sub-samples. The confidence interval of the marginal effects for each sub-sample overlap with the confidence interval of the marginal effects for the full sample. The results suggest combat exposure has a similar influence on different groups of veterans.



Figure A4.1 Marginal Effects of Combat Exposure over Sub-samples on Probability (Major Problem & Distress)
 GME marginal effects for categorical variables computed by setting all observations to category value and comparing to respective base value with all other variables set to sample means. Model includes military control variables in Table 4.2, all deployment related variables in Table 4.6, all other background variables in Table 4.3 and dummy variables for missing values of family structure, health, health behaviors, and childhood experiences.

Table A5.1 displays the influence of military and non-military variables on homelessness. Column 1 displays marginal effects on the primary measure of homelessness, while columns 2-4 display marginal effects on the alternate measure of homelessness. Several military variables influence homelessness. Military service for more than 6 years, in the officer ranks, and in the Air Force are each associated with a decreased risk of homelessness. Military service entry period, military component, and occupational classifications do not explain variation in homelessness. Among non-military variables in the models, minority race or ethnicity and adverse childhood experience are associated with an increased risk of homelessness. Gender does not explain variation in homelessness. As the age variable enters the model non-linearly, the displayed marginal effects at the mean age on financial decline require caution in interpretation.

Table A5.1 Marginal Effects of Background Variables on Homelessness

	(1)		(2)		(3)		(4)	
	Pr(Y=Homeless)		Pr(Y=None)		Pr(Y=Short)		Pr(Y=Long)	
	Effect	SE	Effect	SE	Effect	SE	Effect	SE
<u>Other Military Variables</u>								
Service Entry								
<i>Post 2001 Entry</i>	0.0012	0.0019	-0.0013	0.0008	0.0006	0.0006	0.0007	0.0004
Years of Service								
<i>7-12 years</i>	-0.0028	0.0011	0.0011	0.0005	-0.0011	0.0004	0.0000	0.0003
<i>13-18 years</i>	-0.0054	0.0019	0.0019	0.0008	-0.0013	0.0006	-0.0006	0.0005
<i>19 or more years</i>	-0.0055	0.0021	0.0044	0.0008	-0.0032	0.0006	-0.0012	0.0005
Rank								
<i>Officer</i>	-0.0072	0.0012	0.0044	0.0006	-0.0021	0.0005	-0.0023	0.0004
Branch of Service								
<i>Navy</i>	-0.0014	0.0014	0.0004	0.0006	-0.0003	0.0005	-0.0002	0.0004
<i>Air Force</i>	-0.0046	0.0013	0.0024	0.0006	-0.0015	0.0005	-0.0010	0.0003
<i>Marine Corps</i>	0.0008	0.0018	-0.0004	0.0007	-0.0004	0.0005	0.0008	0.0005
Component								
<i>Reserve or National</i>	0.0014	0.0013	-0.0013	0.0006	0.0004	0.0005	0.0009	0.0004
<i>Separated</i>	0.0021	0.0014	-0.0013	0.0007	0.0005	0.0005	0.0008	0.0004
Occupational								
<i>Electrical Repair</i>	-0.0016	0.0019	0.0004	0.0008	0.0000	0.0007	-0.0004	0.0005
<i>Comm/Intel</i>	-0.0019	0.0017	0.0002	0.0007	-0.0002	0.0006	0.0000	0.0004
<i>Health care</i>	-0.0026	0.0016	0.0015	0.0006	-0.0010	0.0005	-0.0005	0.0004
<i>Other technical</i>	-0.0005	0.0027	0.0000	0.0011	-0.0009	0.0007	0.0009	0.0009
<i>Functional support</i>	-0.0008	0.0016	0.0009	0.0006	-0.0008	0.0005	-0.0001	0.0004
<i>Equipment Repair</i>	-0.0020	0.0016	0.0005	0.0007	-0.0003	0.0006	-0.0002	0.0004
<i>Craft workers</i>	-0.0026	0.0024	0.0009	0.0010	-0.0005	0.0008	-0.0004	0.0006
<i>Service and Supply</i>	-0.0017	0.0016	0.0006	0.0007	-0.0003	0.0005	-0.0003	0.0004
<i>Other</i>	-0.0016	0.0028	-0.0006	0.0014	0.0006	0.0012	0.0000	0.0008
<u>Other Background</u>								
<i>Female</i>	-0.0009	0.0012	0.0008	0.0005	-0.0004	0.0004	-0.0004	0.0003
<i>Age</i>	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Race & Ethnicity								
<i>Black</i>	0.0053	0.0021	-0.0038	0.0011	0.0017	0.0009	0.0021	0.0007
<i>Other</i>	0.0040	0.0020	-0.0014	0.0009	0.0004	0.0007	0.0011	0.0006
<i>Hispanic</i>	0.0039	0.0020	-0.0027	0.0010	0.0022	0.0009	0.0005	0.0005
Childhood Experiences								
<i>Neglect</i>	0.0110	0.0024	-0.0042	0.0011	0.0024	0.0009	0.0019	0.0007
<i>Verbal abuse</i>	0.0022	0.0014	-0.0014	0.0006	0.0009	0.0005	0.0005	0.0004
<i>Physical abuse</i>	0.0023	0.0013	-0.0013	0.0006	0.0009	0.0005	0.0004	0.0003
<i>Sexual abuse</i>	0.0034	0.0017	-0.0018	0.0008	0.0006	0.0006	0.0012	0.0005
Observations	50,522				50,187			
Pseudo-R ²	0.89				0.95			

Column 1 displays estimates with primary binary measure of homelessness. Columns 2-4 display estimates with alternate multinomial measure of homelessness. Effect=GME marginal effects. SE=Standard error. The marginal effect for each continuous variable is calculated with all independent variables set to the mean. The marginal effect for each categorical variable is calculated by changing all observations from the reference value to the category value with all other independent variables set to the mean. All columns include deployment related variables in Table 5.3 and dummy variables for missing childhood experiences.

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