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ABSTRACT

Combat, Casualties, and Compensation: Evidence from Iraq and Afghanistan*

Our research examines the effect of combat deployments to Iraq and Afghanistan on casualties. We use restricted data from the Defense Manpower Data Center (DMDC) and Social Security Administration (SSA) to construct a panel of all U.S. Active Duty service members having served at some point during the years 2001-2012. Casualties disproportionately occur at higher rates among (i) young, white, males (ii) enlisted personnel (iii) less educated personnel (iv) and those in combat job types. Our estimates indicate that overall U.S. military personnel who deployed in an individual year to Iraq or Afghanistan had a 48 per 100,000 higher probability of death than non-deployed military personnel who remained stateside. The increased fatal injury risk of deployed U.S. military personnel is 15 times higher than the national average civilian workplace fatality rate, but roughly equal to the fatal injury risk faced in some of the most dangerous civilian occupations. Our estimates suggest a compensating wage differential equal to $808 per month would be appropriate, in comparison to the current status quo of $225 per month in danger pay (and additional tax benefits) provided to U.S. military personnel deployed into combat zones. The additional compensation should also be adjusted by service or job type.

JEL Classification: H56, J17, J28, J31

Keywords: military, deployment, VSL, casualties, danger pay

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1. Introduction

The wars in Afghanistan and Iraq have produced the highest number of casualties for U.S. military personnel since the Vietnam War. As of May 2018, the total number of combined U.S. military deaths for these two major conflicts was 6,808, with additional wounded personnel numbers coming in at over 50,000 (U.S. DOD, 2018). While casualties and the total number of personnel serving in theater have declined in each of the conflicts (in comparison to their peak totals), there continues to be fierce fighting in isolated regions. The most recent Department of Defense documents show a total of 5,262 U.S. military personnel in Iraq and 9,800 in Afghanistan (U.S. CRS, 2017), with changes being made periodically to account for the fluctuating combat environment (Michaels, 2017). Our research examines the nature of U.S. military combat deployments to Iraq and Afghanistan and their effect on casualties with an eye toward the efficient and equitable ex ante compensation for deployment based fatality risk.

We use restricted U.S. military personnel records from the Defense Manpower Data Center (DMDC) and Social Security Administration (SSA) for the years 2001-2012 as our principal data sources. The data reveal how the casualty figures in Afghanistan and Iraq distribute across gender, race, education, age, rank, marital status, job type, and service. Our empirical strategy uses stateside service members as a control group in comparison to the treatment group of deployed Active Duty service members to Iraq or Afghanistan in a natural experiment type setting to tease out the effects of combat deployments on casualties. Finally, we examine the appropriate level of danger pay for deployed military personnel.

We contribute to a growing body of literature that has examined the effects of combat deployments on a number of medium-term and long-term outcomes including violence, health, family structure, and education (Armey and Lipow 2016, Cunha *et al*. 2017, Cesur *et al*. 2013, Cesur and Sabia 2016, Engel *et al*. 2010, Lyle 2006, Negrusa *et al*. 2014, and Shen *et al*. 2016). Consistent with the previous literature, we use the exogeneity of combat deployments to estimate the effect of combat deployments to Iraq or Afghanistan on casualty rates (See Lyle 2006 for elaboration).

Our preferred estimates indicate that overall, U.S. military personnel who deploy in an individual year to Iraq or Afghanistan observe a 48 per 100,000 increase in the probability of death in comparison to non-deployed military personnel who stay stateside. That said, this overall value masks significant differences across different personnel types. We show that casualties disproportionately occur at higher rates among (i) young, white, males (ii) enlisted personnel (iii) less educated personnel (iv) and those in combat job types. Our estimates suggest a compensating wage differential equal to $808 per month would be appropriate in comparison to the current $225 per month in danger pay (and additional tax benefits) provided to U.S. military personnel deployed into combat zones. Furthermore, extra compensation for fatality risk should be adjusted by service or job type.

2. Institutional Details

There are two key institutional details crucial to our research that we present now prior to our econometric results. First, we document the quantitative importance of military causalities overall and their distribution among demographic characteristics and military occupation. Second, because our interest lies equally in the economically most justifiable ex ante compensation for increased death risk when deployed we explain the current additional monetary compensation for combat deployment in the military.

2.1 Overview of Deployments and Casualties in the Iraq and Afghanistan Wars

The wars in Afghanistan and Iraq are two of the longest foreign wars in the history of the United States. In terms of specific rankings, the war in Afghanistan (roughly 17 years as of 2018) is regarded as the longest of all time, while Iraq ranks as #3 overall in terms of official length (Taylor 2014). The war in Afghanistan began in response to the September 11, 2001, attacks on New York and Washington. Subsequently the U.S. worked with local elements on the ground to root out elements of Al Qaeda in the region and support a friendlier government toward U.S. interests. As a pretext to this the U.S. required the replacement of the Taliban government, which was previously in power in 2001. Although many of the previous leadership entities of the Taliban and Al Qaeda (Osama Bin Laden and Khalid Sheik Mohammad) have been captured or killed, the U.S. and its allies still frequently battle forces in the region (Taliban and Al Qaeda remnants).

U.S. troop totals have varied substantially over the years in Afghanistan, starting with 4,100 personnel at the beginning of the war and gradually increasing to 35,600 in 2008 (Figure 1 below; U.S. Congressional Research Service 2014). In 2008 the U.S. started to dramatically increase the number of troops in Afghanistan, reaching a peak of 99,800 in 2011. Subsequent troop levels have declined substantially with current U.S. personnel totals tallied around 10,000.

As for casualties, death totals in Afghanistan were relatively low by historical standards at the early onset of the war with U.S. service member deaths under 200 per year up until 2008. The increase in troop totals and combat operations led to an increase in the number of deaths per year shortly thereafter, reaching a peak of 499 U.S. service member deaths in 2010. Total number of deaths have declined since peak operations and the total number of U.S. deaths was 15 in 2017 in Afghanistan (Icasualties.org 2018a).

Roughly 1-2 years after the war in Afghanistan started the U.S. made a push to remove

Saddam Hussein from power in Iraq. The war in Iraq officially began in March, 2003. By April 2003 Baghdad had fallen and the U.S. and its allies helped set up a new democratic government. U.S. troop totals were substantially higher in comparison to Afghanistan at the beginning of the Iraq War with U.S. troop totals starting out with around 150,000 service members.

Troop totals stayed at roughly the 150,000 level with the exception of some variations such as the surge until 2009 when the Obama administration slowly started drawing down personnel numbers until the official end of the war. Although the Iraq War officially ended in 2012, U.S. military personnel still have boots on the ground to help support the Iraqi government and their fight against opposition forces (the Islamic State of Iraq and the Levant). Current U.S. troop totals in Iraq are around 5,000.

Total U.S. personnel deaths in Iraq hovered at 800-900 per year for the years 2004 through 2008. The highest number of deaths occurred in 2007 with a total of 904 U.S. deaths for that year. Total U.S. deaths declined dramatically after 2009 until the official end of the war in 2012. Given the U.S. still has troops in Iraq as of May 2018, there are still periodic deaths although relatively small in number. In 2017, there were a total of 17 U.S. deaths in Iraq (Icasualties.org 2018b).

2.2 Additional Monetary Compensation for Combat Deployment

There are several monetary supplements for U.S. military personnel who are deployed into combat zones. Military personnel who are deployed into combat zones are entitled to Hostile Fire and Imminent Danger pay (HFP/IDP) – or more commonly known as simply danger pay. There are established pay guidelines for military personnel eligible for HFP/IDP (Department of Defense 2017a). The guidelines state:

> *"HFP/IDP is payable at the monthly rate of $225.00. Service members will receive $7.50 for each day they are on duty in an IDP area up to the maximum monthly rate of $225. Members who are exposed to a hostile fire or hostile mine explosion event are eligible to receive non-prorated Hostile Fire Pay (HFP) in the full monthly amount of $225. Members cannot receive both IDP and HFP in the same month."*

HFP/IDP is often confused with Hardship Duty Pay-Location (HDP-L). HDP-L is different from HFP/IDP in that it can be received by personnel in non-combat areas. The Department of Defense (2017b) guidelines for HDP-L are that:

> *"HDP-L is compensation paid to members assigned outside the continental United States in Quality of Life (QoL) Hardship locations -- Locations where QoL living conditions are substantially below the standard most members in the continental United States would generally experience. HDP-L is intended to recognize the extraordinary arduous living conditions, excessive physical hardship, and/or unhealthful conditions that exist in a location or assignment. Rates are payable in increments of $50, $100, or $150 a month based on the level of QoL hardship in a given area."*

HDP-L is currently set at $100 per month if a military member is stationed in Iraq or Afghanistan (Military.com 2016). The compensation is received in addition to HFP/IDP.

U.S. military personnel deployed into combat zones also receive special tax exemptions, known formally as the Combat Zone Tax Exclusion (CZTE), as the result of current Internal Revenue Service guidelines (IRS 2017). The IRS details six specific income tax exclusions (at both the federal and state levels) related to the CZTE: (i) Basic pay for every month the military member is present in a combat zone, (ii) reenlistment bonuses, (iii) school loan repayments, (iv) HFP/IDP, (v) discharge benefits, and (vi) awards and other financial incentives – personnel can exclude associated income for submissions made while in a combat zone. Notably, military pay earned while in a combat zone is still subject to Social Security and Medicare taxes. Enlisted and Warrant Officers are allowed to exclude all military pay for each month present in a combat zone. In contrast, Commissioned Officers are limited to the highest rate of enlisted pay plus HFP/IDP for each month present in a combat zone.

The previous literature has found that the CZTE is the largest additional monetary benefit military personnel receive while deployed into combat zones (Pleeter *et al*. 2011). HFP/IDP cost the Department of Defense $789 million in 2009 while the cost to the Treasury for CZTE was $3.6 billion – approximately 4.5 times the cost of HFP/IDP. The average value of the CZTE for deployed service members was $5,990 in 2009. All the pay supplements can substantially alter the take home pay for service members deployed into combat zones.

3. Data Details

We combine Social Security Administration (SSA) and Defense Manpower Data Center (DMDC) data to construct a panel of all Active Duty military personnel stationed in the United States and deployed to Iraq or Afghanistan for the years 2001-2012. The SSA data provide the date of death for all service members who died during the sample time period regardless of whether it was in theater or otherwise. The individual level DMDC data provide information on the general characteristics for each service member.[1]

The variables in the DMDC information include annual data, measured each September, on age, gender, military branch, Military Occupational Specialty (MOS), rank, marital status, number of dependents, education, race, and Armed Forces Qualification Test score. [2] We breakdown the MOS variable into four subcategory job types including Service, Combat, Support, and "Other" Job. We also use DMDC data on unit identifier code (UIC) at the battalion level to cluster standard errors and include battalion fixed effects in some of the models.

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[1] The data do not include information on non-Active Duty military such as National Guard or Reserve members.

[2] The AFQT is a subtest of the larger Armed Services Vocational Aptitude Battery (ASVAB) and is formed from a composite score of four general areas: arithmetic reasoning, word knowledge, paragraph comprehension, and mathematics knowledge.

DMDC deployment records identify whether an individual was deployed in any given year. The data identify the country of deployment and in our primary analysis we use it to construct a dummy variable for an individual being deployed to Iraq or Afghanistan in any year.[3]

Table 1 provides descriptive statistics. In our sample, about 17,000 service members died during 2001-2012; 6,267 were attributable to combat in Iraq or Afghanistan. Figures 2 and 3 break down U.S. active duty member deaths in Iraq and Afghanistan during 2001-2012. Deaths are not proportional to distribution in the sample.

Although Blacks make-up about 20% of our sample, they only represent about 10% of theater deaths. Women represent 15% of the sample, and they make up 2% of the theater deaths. Deaths are also skewed towards enlisted, younger, and less educated military personnel. Officers are 16% of our sample, but only 10% of theater deaths, those with high school or less are 74% of the sample and represent 84% of theater deaths, and the average age of death is 26, while the average age in the sample is about 29. Turning to Figure 3, unsurprisingly, 55% of those killed in theater in Iraq and Afghanistan were in combat positions, despite being only 11% of the sample. Finally, about 70% of combat deaths were incurred by the Army, and 23% were incurred by the Marines.[4]

[3] The deployment data from DMDC appears to be subject to some measurement error. For example, the deployment data state that more military have been deployed to Kuwait than Iraq. However, if a service member was coded as simultaneously in Kuwait and Iraq, we code them as having been deployed to Iraq, and if someone is coded as being in Kyrgyzstan and Afghanistan simultaneously we code them as being deployed to Afghanistan.

[4] Unfortunately the available data on injuries are somewhat incomplete. We were only able to obtain information on combat injuries in Iraq and Afghanistan. We were not able to obtain information on stateside injuries and were therefore not able to accurately estimate the effect of deployment on injuries. An obvious extension to this study would be to analyze the effect on injuries when such data become available. In terms of raw comparisons, the data in Table 1 show military personnel are about six times more likely to obtain a combat injury in comparison to a combat fatality.

4. Empirical Method

The literature on combat deployments (Armey and Lipow 2016, Cunha *et al*. 2017, Cesur *et al*. 2013, Cesur and Sabia 2016, Engel *et al*. 2010, Lyle 2006, Negrusa *et al*. 2014, and Shen *et al*. 2016) has used a variety of techniques including comparing (1) deployed service members with those stateside, (2) combat deployments versus non-combat deployments, (3) civilians versus combat deployments, and (4) active duty versus non-active duty deployments to estimate the effects of combat deployments on economic and social outcomes. Here we use an estimation strategy that is the most relevant for the purposes of our research – comparing fatalities of stateside U.S. service members with those deployed to Iraq or Afghanistan.

4.1 Regression Model

To identify the effect of deployment into combat zones on fatality rates for Active Duty U.S. service members, we use the regression model

$$Fatality_{it} = \alpha + \beta Deployment_{it} + X'_{it}\theta + \varepsilon_{it}$$

where $Fatality_{it}$ takes a value of one if service member *i* dies in year *t* and zero otherwise. The binary indicator variable $Deployment_{it}$ is equal to one if service member *i* is deployed to either Iraq or Afghanistan in year *t* and zero if stationed in the U.S. for the entire year. The vector X' is a set of individual control variables including age, gender, job type, rank, marital status, number of dependents, education, race, ethnicity, score on the Armed Services Vocational Aptitude test (AFQT) battalion fixed effects, time fixed effects, and ε, which is an idiosyncratic error term. Here β is the coefficient of interest and can be interpreted as the effect of being deployed into a combat zone on death.

4.2 Limitations

The assumption that individual level deployments are random (which is required for obtaining unbiased estimates) is generally accepted in the literature. While discussed in a number of articles, Lyle (2006, page 323) provides a specific rationale for why individual-level deployments are essentially randomized in the military:

> *"The army's Human Resources Command assigns soldiers to division-level units every 2–4 years based on the "needs of the army." This army-specific term captures the essence of all assignments: world events drive army assignments. While soldiers may indicate a preference for a particular division, the timing of the move and the assignment of a soldier to a subordinate army unit are largely independent of a soldier's preferences.*

Lyle (2006) and other similar studies argue that self-selection into deployments by individual military personnel is incredibly difficult and that these deployments may be considered exogenous by researchers. Therefore, comparisons of deployed versus non-deployed service members is a plausible identification strategy as long as researchers include the appropriate control variables in their regressions.

Although the exogeneity of individual deployments is generally considered a sound identification strategy in the literature, recent work shows how some studies may have biases present if the appropriate controls are not included in the regressions (Armey *et al.* 2017). For example, race and family formation often play a factor in deployment status – specifically, they find that African Americans or those who were married and had children were far less likely than other service members to have been deployed to serve in combat zones.

Furthermore, it may also be the case that healthy service members are more likely to deploy than unhealthy military personnel because personnel with a medical concern are red flagged and not allowed to deploy. Although we have data on standard variables such as race and marital status, which we include in the regressions, we do not have information on the medical records of personnel so we cannot control for medical concerns. Finally, it may also be the case that some military personnel fake injuries or intentionally become pregnant to get out of combat deployments. Because such combat avoidance actions are incredibly difficult to obtain data on they are omitted from our regressions; we are unaware of any recently published articles on any combat avoidance actions in the deployment literature.

5. Regression Results

Table 2 presents our regressions comparing all stateside U.S. active duty personnel with those deployed to Iraq or Afghanistan. All four columns show positive coefficients; the point estimates indicate that, compared to remaining stateside, deployment in a given year into Iraq or Afghanistan leads to an increase in the probability of death for individual service members. The coefficients range between 0.0004763 and 0.0009649, so that military members deployed to Iraq or Afghanistan face between about a 48 per 100,000 and a 96 per 100,000 higher risk of death in a year compared to equivalent non- deployed stateside military personnel. All four coefficients are statistically significant at the 1% level. Our preferred estimates are in column 4, which are from the regression including all personal characteristics controls plus unit and time fixed effects. The estimates from column 4 suggests that overall, military personnel who deployed in an individual year to Iraq or Afghanistan had about a 48 per 100,000 increase in the probability of death compared to non-deployed military personnel who remained stateside.

Table 3 presents results broken down by service type (Army, Air Force, Navy, and Marines). The Army results in columns 1-4 show positive coefficients in all four of the specifications and range in value from 0.000657 to 0.00106. In addition, all four of the coefficients are statistically significant at the 1% level. Out of all four services military personnel serving in the Army had the highest increase in the probability of death when being deployed to Iraq or Afghanistan. Our preferred estimates from column 4 indicate that Army soldiers who deploy to Iraq or Afghanistan have about a 66 per 100,000 increase in the probability of death in comparison to non-deployed Army personnel who stayed stateside. In contrast, the Air Force results show a very different story for deployed service members. Columns 5-8 have coefficients ranging in value between -0.0000743 and 0.000193 with none of the coefficients statistically significant at any of the conventional levels. Air Force personnel saw little to no difference in fatality rates when deployed into Iraq or Afghanistan in comparison to staying stateside.

The Navy results in Table 3 show a positive relationship with deployment and fatality rates. The coefficients in columns 9-12 range in value from 0.0003157 to 0.000414. The coefficients in columns 9 and 10 are statistically significant at the 1% level and those in columns 11 and 12 are statistically significant at the 5% level. The Marine results also show a positive effect on death for being deployed into Iraq or Afghanistan. The coefficients range in value between 0.00036 and 0.00084, and all four coefficients in columns 13-16 are statistically significant at either the 1% or 5% levels. Based on our preferred specification, which includes control variables and unit and time fixed effects, Navy personnel deployed into Iraq or Afghanistan faced about a 37 per 100,000 higher chance of death than if they had remained stateside and Marines deployed into Iraq or Afghanistan faced about a 36 per 100,000 higher chance of death than if they had remained stateside.

Table 4 displays results broken down by job type (Combat, Support, Service, and Other). The most prominent results are those in columns 1-4, which indicate that combat personnel saw a dramatic increase in the probability of death, between 179 per 100,000 and 234 per 100,000 in comparison to their stateside counterparts. All four of the coefficients in columns 1-4 are significant at the 1% level. Our preferred estimates from column 4 show that combat personnel who deploy to Iraq or Afghanistan observed a 180 per 100,000 increase in the probability of death in comparison to non-deployed combat personnel who stayed stateside. The Support Job type results in columns 5-8 also show a positive relationship with deployment status and fatality rates. All four of the coefficients are statistically significant at the 1% level and range in value between 0.00028 and 0.00069. The estimates from our preferred specification indicate Support personnel face a 30 per 100,000 higher probability of death than equivalent non-deployed Support personnel.

The rest of the job types (Service and Other job types) in Table 4 show coefficients often changing from negative to positive (or vice versa) depending upon the specification used. In addition, the rest of the job type results appear to be imprecise in comparison to the Combat and Service Job type results when looking at their levels of statistical significance, particularly those including time and unit fixed effects. There appears to be little or no evidence of a positive effect of deployment on fatalities when focusing on the Service or Other job types.

6. Implications for Military Pay Policy

Our preferred estimates of the effect of deployments on fatalities from the pooled data (column 4 in Table 2) indicate that military personnel who deployed in an individual year to Iraq or Afghanistan had about a 48 per 100,000 increase in the likelihood of death in comparison to non-deployed military personnel who stayed stateside. To understand how this compares to death rates in the civilian world, we now present information from the National Safety Council (2015) and the U.S. Department of Labor (2012).

6.1 Military Fatality Risks Versus in Civilian Employment

Figure 4 shows the rates of unintentional-injury-related deaths in the U.S. per 100,000 population during 2001-2012. Over the 12 years fatalities occurring at home steadily rose, while motor vehicle fatalities fell. Non-motor vehicle fatalities in public and work-related fatalities essentially remained constant. By 2012 the rate of accidental deaths in the home was about 20 per

100,000 population; deaths in motor vehicle accidents was about 12 per 100,000 population; deaths in public unrelated to motor vehicle accidents was 8 per 100,000 population; and deaths at work was about 1 per 100,000 population. The total rate of unintentional-injury-related deaths in the U.S. in 2012 was about 40 per 100,000 population. If the average person in the military stationed in the U.S. faced roughly the same risk of an accidental death as the typical civilian, then deployment to Iraq or Afghanistan more than doubled the chance of an injury-related death. For combat personnel, the increase in the chance of death from deployment to Iraq or Afghanistan is more than four times the average rate of unintentional-injury-related deaths among U.S. civilians.

The data in Figure 4 do not adjust fatality rates for the time exposed to risk. Each rate is the number of fatalities per 100,000 population. The risk of a fatal motor vehicle accident rises as the time spent in a car rises and work-related deaths per 100,000 population does not account for non-workers, part-time workers, or seasonal workers. Figure 5 examines the rate of workplace fatalities for high-risk occupations in 2012 using data from the Census of Fatal Occupational Injuries (CFOI). The Bureau of Labor Statistics generates the information contained in the CFOI by examining death certificates, medical examiner reports, OSHA reports, and workers' compensation records to determine those deaths that are work-related. The rates are expressed relative to 100,000 full-time equivalent (FTE) workers; total work hours divided by 2,000 (40 hours per work day × 5 days per week × 50 weeks per year). The rates represent the average incremental increase in the chance of death from working in each high-risk profession, and so represent a natural comparison to the incremental increase in the chance of death from deployment to Iraq or Afghanistan.

In 2012, the average rate of work-related deaths in the U.S. across all occupations was about 3 per 100,000 FTE workers (U.S. Department of Labor, 2013). Based on our preferred specification, the incremental risk of dying due to deployment to Iraq or Afghanistan for all military personnel was 15 times higher than the chance of dying in the average civilian job and for combat personnel 56 times higher than the chance of dying in the average civilian job.[5] The two highest risk occupations in Figure 5 are logging workers and fishers and related fishing workers with fatality rates of about 128 per 100,000 FTE workers and 117 per 100,000 FTE workers. The remaining eight high-risk occupations have fatality rates ranging from about 53 per 100,000 FTE workers to 17 per 100,000 FTE workers. Except for the two highest risk occupations the increase in fatal injury risk from deployment to Iraq or Afghanistan is 1-2 times higher than the incremental risk of death in non-military high-risk occupations. For combat personnel the incremental risk of death from deployment is 40 percent higher than the risk of workplace death in logging, the most hazardous civilian occupation in 2012.

6.2 Value of a Statistical Life

It is possible to monetize the economic implications of the increase in deployment-related fatal injury risk and, in turn, infer a specific value for DOD to use for supplemental (danger) pay. The calculation involves the standard value of statistical life (VSL) estimates from the economics literature. Although there are many ways to estimate VSLs, the predominate approach is to regress some measure of wage against the probability of a work-related fatal injury, controlling for other factors that might also affect wages such as the rate of non-fatal workplace

[5] Military personnel deployed to Iraq or Afghanistan did not choose the hours they were exposed to risk, unlike civilians who face workplace hazards only while working. The entire time deployed, military personnel face a higher chance of death. The rates we present per 100,000 military personnel are roughly twice as large as equivalent rates per 2,000 hours of risk exposure. The average person in the military deployed to Iraq or Afghanistan spent 5.7 months in theater or 4,118 hours exposed to risk (24 hours × 7 days × 4.3 weeks per month × 5.7 months), slightly more than twice the number of hours of a FTE worker. Because deployment to Iraq or Afghanistan both raised the risk of death per hour of exposure and results in more hours exposed to risk as compared to the average civilian worker, the appropriate risk comparison is between the incremental risk from deployment per 100,000 military personnel and workplace fatalities per 100,000 FTE workers.

injury, workers' compensation benefits, education, race, marital status, and union membership. The regression then provides an estimate of the willingness of workers as a group to pay for a small reduction in risk, $\frac{\partial w}{\partial \pi}$, where w is the wage rate and π is the probability of a workplace fatality. For example, suppose that based on estimates of $\frac{\partial w}{\partial \pi}$ an average worker is willing to sacrifice $900 per year to reduce risk by 1 in 100,000, meaning that a 100,000 workers would collectively pay $9 million and one life would be saved. The life saved would not be known beforehand, but in a sense, would be drawn randomly; hence, the resulting value is referred to as the value of a statistical life. Mathematically, the VSL = $(\frac{\partial w}{\partial \pi})(\frac{1}{\pi})$.

Economists have found the values for VSL estimates in the $4 million-$10 million range (Aldy and Viscusi 2007, 2008; Kniesner, Viscusi, Woock, and Ziliak 2012; Kniesner, Leeth, and Sullivan 2015; Leeth and Ruser 2003; Rohlfs, Sullivan, and Kniesner 2015; Viscusi and Aldi 2003; and Viscusi 1993, 2004). Although there has been some work using VSL estimates in military settings, there is currently no standard VSL estimate in place within the Department of Defense to use on personnel matters (Greenstone, Ryan, and Yankovich 2017; Kniesner, Leeth, and Sullivan 2015; Rohlfs and Sullivan 2013; Rohlfs, Sullivan, Treistman, and Deng 2015; Rohlfs, Sullivan, and Kniesner 2016).

Other government agencies generally use a VSL of $8 million-$10 million when considering the value of regulations that reduce mortality risk. The U.S. Environmental Protection Agency (EPA), for instance, recommends using $7.4 million ($2006) updated yearly for inflation as the default VSL based on fitting a Weibull distribution to 26 separate VSL estimates (U.S. EPA 2010). The $7.6 million represents the central estimate (mean) of the fitted distribution. The recommended VSL for 2016 after adjusting for the general rise in prices using the Consumer Price Index would be $8.8 million. The Department of Transportation (DOT) in

2016 suggested researchers use a slightly higher value of $9.6 million per statistical life in cost-benefit analysis calculations (U.S. DOT 2016). The DOT value is the average VSL found in nine relatively recent labor market studies using CFOI data to determine fatality risk, corrected for inflation and the increase in real income over time. Other government agencies have not issued general directives on the appropriate VSL to use in cost-benefit analyses, but most appear to base their calculations on the recommendations of the EPA or DOT or from a survey of VSL estimates such as Viscusi and Aldy (2003) (U.S. Department of Labor 2016 a,b, U.S. Department of Homeland Security 2016, and U.S. Department of Health and Human Services 2017).

VSLs vary by the risk preferences of the group considered. Less risk averse individuals who sort into high-risk occupations such as the military will require less compensation for an increase in the chance of death than more risk averse individuals. VSLs used by government agencies in cost-benefit analyses are based upon empirical studies that estimate VSLs using data drawn from broad national samples of U.S. civilian workers with an average level of fatal injury risk considerably smaller than the incremental risk of military personnel deployed to Iraq or Afghanistan.

Three studies examining risk compensation within extremely high-risk occupations indicate that the VSL for military personnel may be much lower than in the overall civilian working population. As shown in Figure 5, commercial fishing is one of the most dangerous occupations in the U.S., and commercial fishing in the Alaskan Bering Sea is even more dangerous than fishing in general. Lavetti (2017) examines a sample of commercial fishing deckhands in the Alaskan Bering Sea who face a fatal injury risk that varies by month from a low of 100 per 100,000 FTE workers to a high of 600 per 100,000 FTE workers (Figure 1). At the 25^{th} percentile of fatal injury risk (120 per 100,000 FTE workers) the VSL for deckhands is $6.7

million, but at the 75th percentile of fatal injury risk (410 per 100,000 FTE workers) the VSL is only $1.5 million. Felthoven, Horrace, and Schnier (2009) examine a somewhat broader sample of Alaskan commercial fishers with a mean fatal injury risk of about 142 per 100,000 FTE workers. Their VSL ranges from $4.6 million to $5.5 million depending on the empirical specification. Finally, Goucher and Horrace (2012) estimate the VSL of paid guides from developed countries who were leading mountain climbing expeditions in the Himalayan Mountains of Nepal and India. The mean probability of death for paid guides over the period they examine (1987-2007) was 450 per 100,000 and the estimated VSL is in the $4.5 million to $6.0 million range.[6]

Although the studies of private-sector high-risk occupations just described imply using a lower VSL for military personnel, government agencies have not adopted varying VSLs for specific subpopulations who may have higher or lower VSLs than the general population. For instance, VSLs rise as income rises, yet government agencies such as the EPA and DOT use a single VSL to evaluate the benefits of safety regulations regardless of the income of the subpopulation affected. To provide calculations that DOD might use in adjusting their danger pay for military personnel, we will combine our results with the recommended VSL from DOT.

6.3 Implications for Military Hazardous Duty Pay

We have seen that, overall, military personnel deployed to Iraq or Afghanistan face about a 48 per 100,000 increase in the chance of death in a given year compared to their stateside counterparts. This translates into a compensation value of: $9.6 million × 0.0004795 = $4,603. Digging further into the data, we find that military personnel deployed to Iraq or Afghanistan spent on average 5.7 months in theater out of the year. Therefore, additional monthly

[6] All values have been converted to $2016 using the CPI.

compensation (compensating wage differential) while in theater should equal roughly \$4,603/5.7 = \$808 per month.

As discussed previously, the current compensation system mainly provides additional compensation for personnel deployed into combat zones through the HFP/IDP and CZTE. The current system has been shown to benefit officers and personnel who are not the most at risk for death (Pleeter *et al*. 2011). It may therefore be efficient to change the current system toward one which provides additional monetary compensation to the military personnel who see the biggest change in their probability of death when deployed into a combat zones.

For example, the most extreme change in fatality rates appears to be those estimates associated with military personnel described as in Combat Job types. Our preferred estimates (column 4 in Table 4) show that combat personnel who deploy to Iraq or Afghanistan experience a 180 per 100,000 increase in the probability of death compared to non-deployed combat personnel who stay stateside. This suggests a compensating wage differential equal to \$3,032 per month for combat type personnel.[7] A pay variation across job types may be of considerable interest to policy makers if their goal is to more efficiently compensate military personnel based on changes in fatality rates while deployed. Although outside the scope of our research here, further analysis could be done by breaking down values for all MOS job types across the entire Department of Defense.

The calculations also suggest that a tax credit of \$808 per month while being deployed into a combat zone would be appropriate for policy makers if their preference is to use a standard compensating wage differential for danger pay across all personnel types in DOD. This is in contrast to the current status quo of \$225 per month in danger pay (and additional tax benefits through the CZTE) provided to U.S. military personnel deployed into combat zones.

[7] \$9.6 million × 0.0018 = \$17,280. On a per month basis, this is \$17,280/5.7 months = \$3,032 per month.

Using differing compensating wage differentials by job type would benefit some military personnel over others. In particular, the combat job types would most dramatically benefit under such as system because our estimates suggest they should be receiving a compensating wage differential of $3,032 per month while in theater. Some non-combat troop types could see their pay cut under such a system given the estimates provided in Table 3. Regardless of the specific amount chosen, policymakers could eliminate the current HFP/IDP and CZTE compensation system in place of a more straightforward tax credit. This would simplify the compensation system as well as more accurately reflect the true compensating wage differential based upon actual risk.

Of note, many of our estimates (such as those for Air Force personnel) suggest that some personnel types actually do not see an increase in the probability of death when deployed into combat zones. This raises questions about whether personnel should be receiving danger pay at all. Instead, personnel who are subject to no greater fatality rise could receive additional compensation through the HDP-L. In terms of policy implications, this is what our estimates indicate, but such a pay policy is likely to receive extreme pushback from affected groups because it is effectively a decrease in their current pay. Policymakers will have to decide the best course of action to take given the political and budgetary climate at the time.[8]

Previous studies have found that the CZTE costs the U.S. government roughly 4.5 times the amount of the HFP/IDP (Pleeter et al. 2011). Given standard danger pay is equal to $225 per month, the CZTE costs roughly $4.5 \times \$225 = \$1,013$ per month on average for military personnel

[8] An extension of our research would include the incidence of and compensation for non-fatal injuries. Due to data limitations (a lack of information on stateside non-fatal injuries) we could not examine the effect of combat deployment on injuries. Personal discussions with military personnel on the topic indicate mixed feelings on whether non-fatal injury values should be included in danger pay. Some held the view that injury compensation should be handled strictly through the Veterans Administration's disability compensation program and that danger pay should be allocated solely based on fatality risk.

deployed into combat. Therefore, the current compensating wage differential is equal to around \$225 + \$1,013 = \$1,238 per month. If policy makers would prefer to keep combat pay standardized across job types, then our recommended value of \$808 per month in combat pay is actually lower than the \$1,238 per month policy currently in place. Consequently, enacting a \$808 per month tax credit for personnel deployed to combat zones in replacement of the current pay structure could lead to substantial budgetary savings for the U.S. government.

Another alternative would be to enact a revenue neutral option. For example, the DOD could implement our recommended danger pay value of \$808 per month and then use the cost savings to increase other types of pay such as bonuses, regular pay, or life insurance payouts. Our estimates suggest a value of \$808 per month for danger pay would be appropriate if policymakers would prefer to keep the pay structure standardized across all military members.[9] A possibly better policy would be to vary the danger pay by service or job type. However, that option seems unlikely in the current political environment. Regardless of the course of action taken, the current pay structure appears to be outdated and needs updating to more accurately reflect the efficient compensation by risk level across military personnel.

7. Conclusion

The research presented here uses restricted data from the Defense Manpower Data Center (DMDC) and Social Security Administration (SSA) to examine the demographics of

[9] Our recommendation is in line with other research on the topic (Simon et al. 2011; Department of Defense 2012). The 11th Quadrennial Review of Military Compensation (QRMC) states "The QRMC concludes that replacing the CZTE with a refundable Combat Tax Credit would equalize the benefit for all members. Based on the period during which the member received HFP, a credit would also eliminate factors such as family income and size from calculation of the combat tax exclusion. A tax credit is independent of tax bracket and, like all tax credits, would be applied after an individual's tax liability is computed. By making this a refundable tax credit, junior members who have little or no tax liability would receive the full amount of the credit as a refund. A tax credit would also eliminate the current practice of high-income members using the tax exclusion to qualify for the Earned Income Tax Credit. Unlike the current tax exclusion, a tax credit would also be easier for members to understand and quantify." The Quadrennial Review further notes that "a refundable tax credit of \$850 per month could replace current policy at no additional cost."

U.S. military combat deployments to Iraq and Afghanistan and deployment's effect on casualties. As a primary identification strategy we use stateside service members as a control group in comparison to the treatment group of Active Duty service members deployed to Iraq or Afghanistan. We also present estimates of the appropriate level of danger pay for deployed military personnel.

Point estimates presented suggest that, in general, U.S. military personnel who deployed in an individual year to Iraq or Afghanistan experienced about a 48 per 100,000 increase in the probability of death in a given year in comparison to non-deployed military personnel who stayed stateside. This translates into a $808 per month compensating wage differential when standard VSL values are applied from the economics literature. This is in comparison to the current situation of $225 per month in danger pay and additional tax benefits through the CZTE provided to U.S. military personnel deployed into combat zones. We also show that there is considerable variation in fatality risk when deployed across different job types and services. Our estimates therefore suggest that the standard values for danger pay used by DOD should more properly be adjusted by service or job type.

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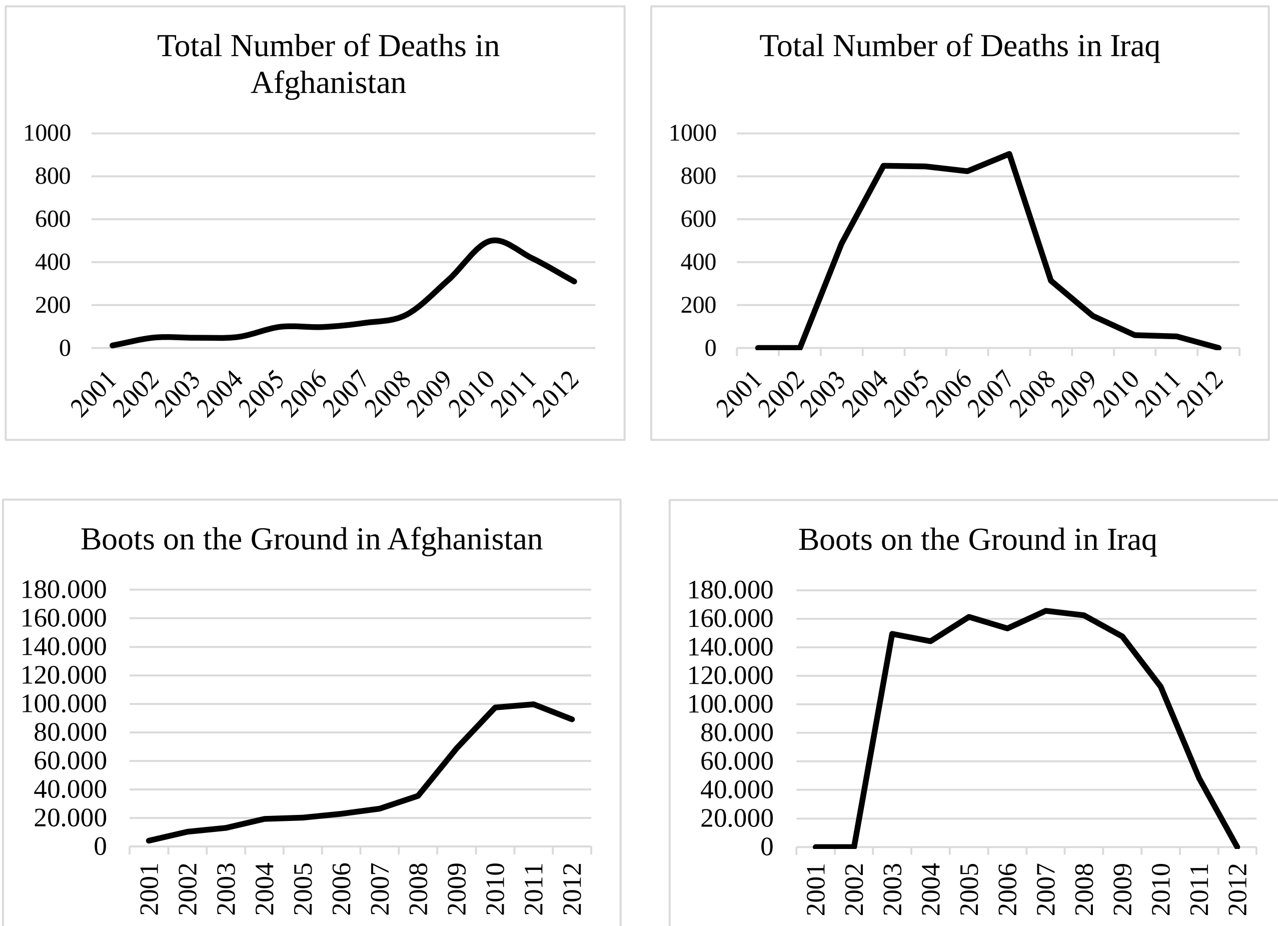
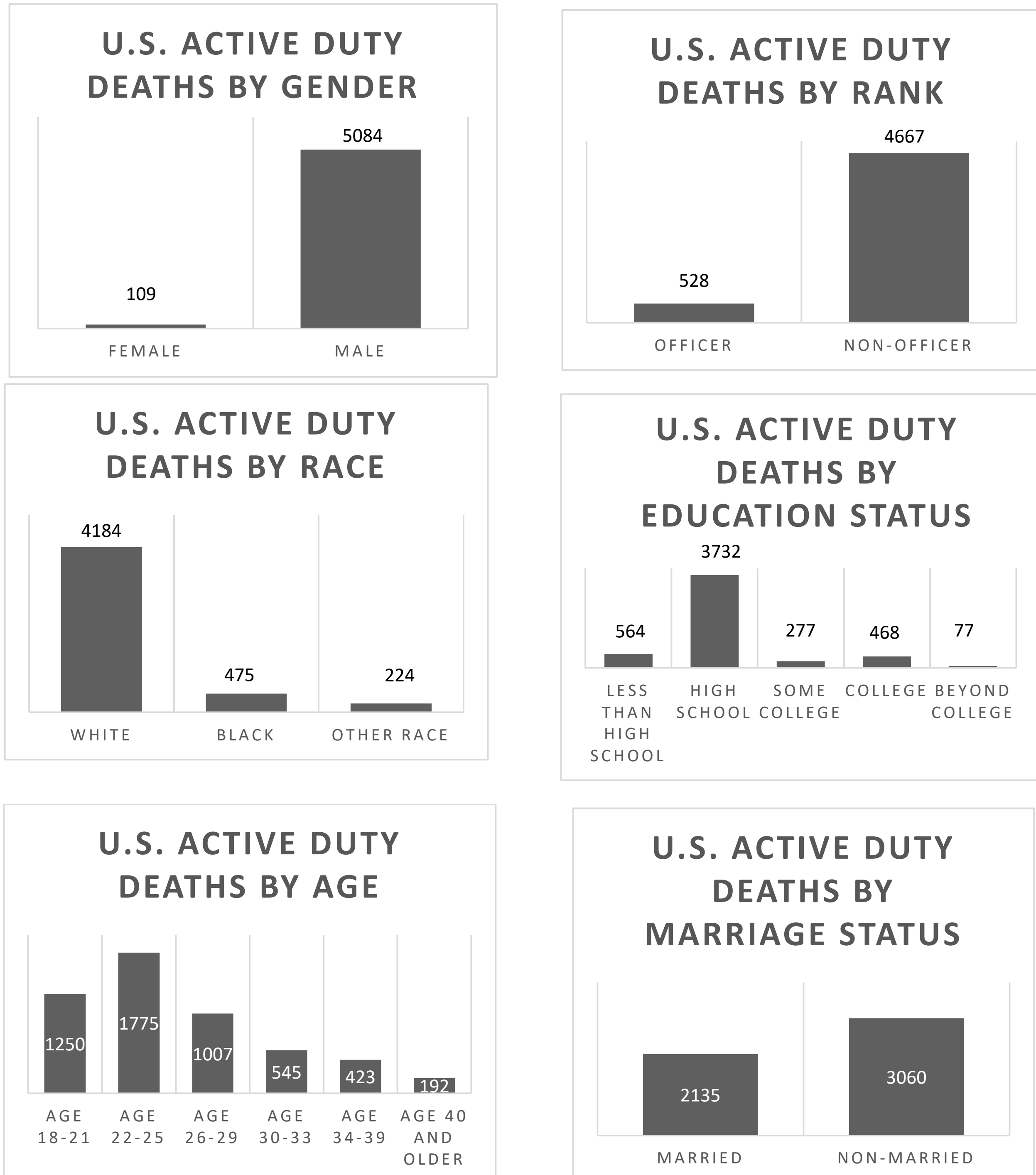
Figure 1: Total number of Deaths and Boots on the Ground for U.S. Troops
in Iraq and Afghanistan by Year



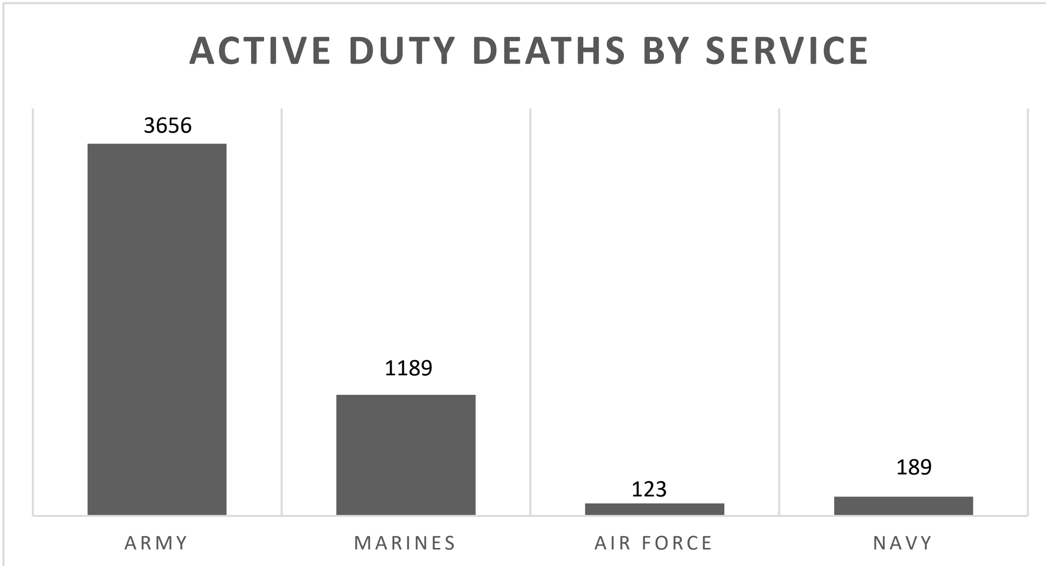
Notes: Data for the graphs taken from Icasualties.org 2018a, Icasualties.org 2018b, and U.S. Congressional Research Service (2014). Exact numbers for boots on the ground were not available for Afghanistan in 2001. Therefore, we use January 2002 totals for boots on the ground instead for that year.

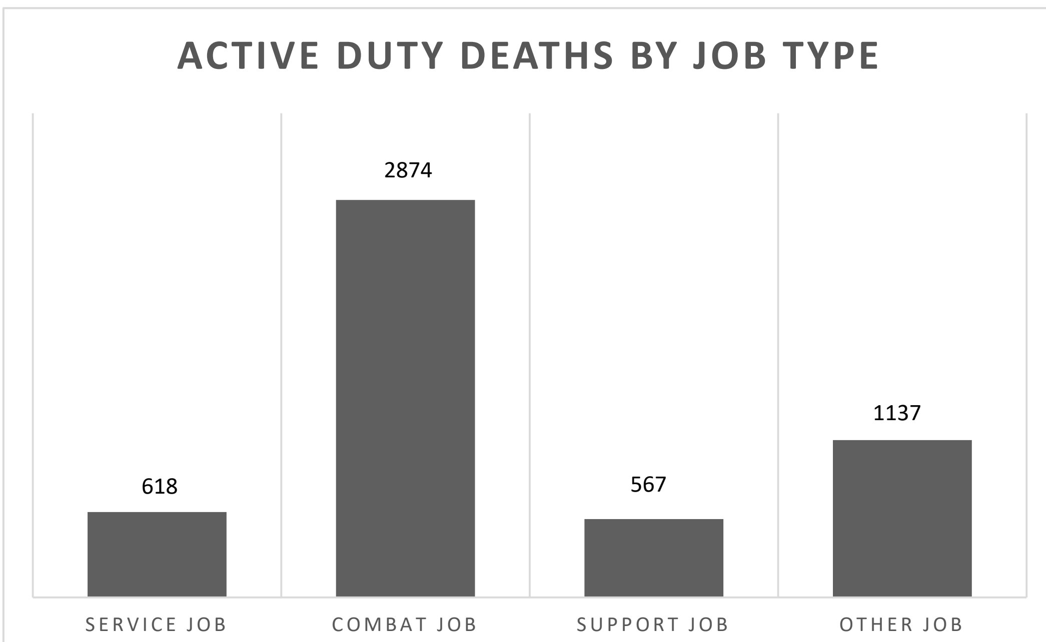
Figure 2: U.S. Active Duty Deaths in Iraq and Afghanistan by Demographic



Notes: Data for the figures are taken from SSA and DMDC records for the years 2001-2012. National Guard, Reserve troops, and those observations with missing characteristics are omitted from the totals.

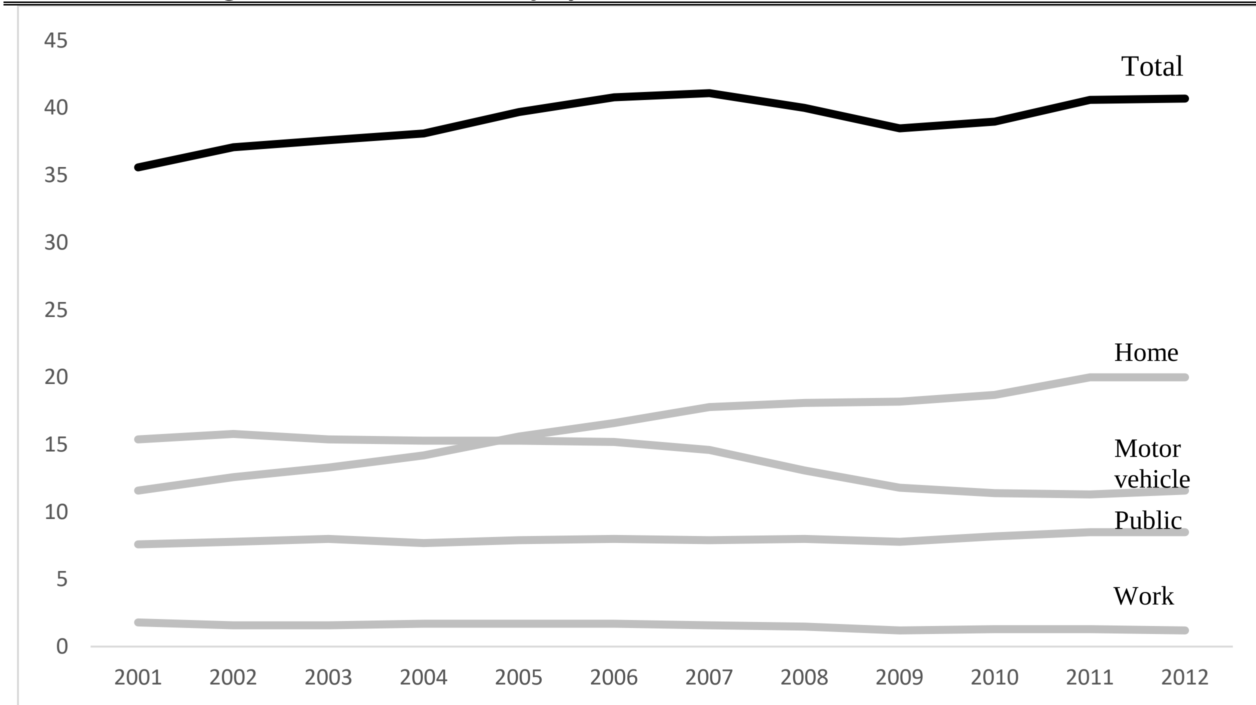
Figure 3: U.S. Active Duty Deaths in Iraq and Afghanistan by Service and Job Type





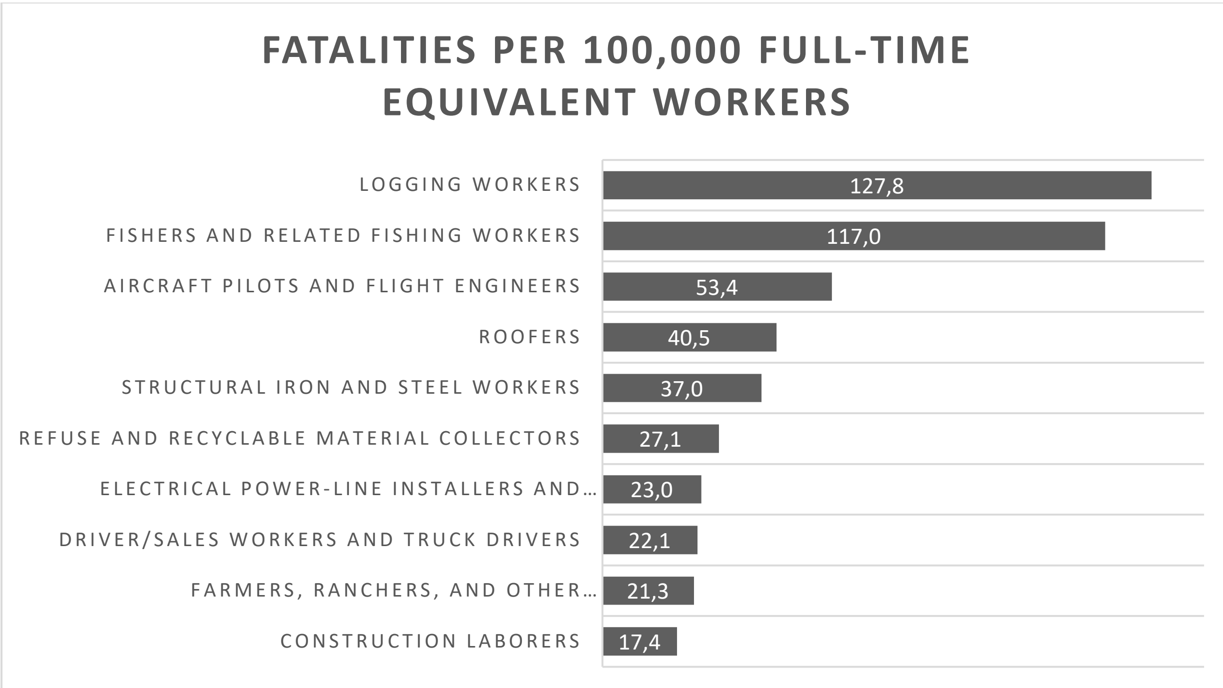
Notes: Data for the figures are taken from SSA and DMDC records for the years 2001-2012. National Guard, Reserve troops, and observations with missing characteristics are omitted from the totals.

Figure 4: Unintentional-Injury-Related Deaths in the U.S., 2001-2012



Notes: Data from National Safety Council (2015).

Figure 5: U.S. Civilian Occupations with High Fatal Injury Rates, 2012



Notes: Data from Chart 3, U.S. Department of Labor (2012).

Table 1: Summary Statistics

	Observations	Mean	Standard Deviation	Minimum	Maximum
Death	17,326,043	0.000854	0.0292100	0	1
Combat Death	17,326,043	0.000272	0.0164995	0	1
Combat Injury	17,326,043	0.001628	0.0403200	0	1
Deployed	17,326,043	0.138231	0.3451428	0	1
Married	17,326,043	0.505322	0.499970	0	1
Number of Dependents	16,747,722	1.294570	1.510437	0	26
AFQT Percentile	13,929,465	60.69650	18.43442	1	98
Officer	17,323,097	0.158826	0.365514	0	1
Age	17,320,379	28.75695	7.954840	16	94
Female	17,323,097	0.150238	0.35730	0	1
Hispanic	16,425,298	0.102641	0.30349	0	1
Asian	16,425,298	0.032641	0.17769	0	1
Other Ethnicity	16,425,298	0.86472	0.34202	0	1
Black	16,064,759	0.190855	0.39298	0	1
White	16,064,759	0.754708	0.43026	0	1
Other Race	16,064,759	0.054436	0.22688	0	1
Army	17,326,043	0.354808	0.478455	0	1
Marines	17,326,043	0.136734	0.343566	0	1
Navy	17,326,043	0.248459	0.432120	0	1
Air Force	17,326,043	0.222832	0.416146	0	1
Less than High School	16,878,831	0.055496	0.228945	0	1
High School	16,878,831	0.684124	0.464864	0	1
Some College	16,878,831	0.083102	0.276040	0	1
College (4 year degree)	16,878,831	0.114015	0.317829	0	1
Beyond College	16,878,831	0.063264	0.243470	0	1
Service Job	17,325,219	0.248943	0.43240	0	1
Combat Job	17,325,219	0.109942	0.31282	0	1
Support Job	17,325,219	0.113070	0.31668	0	1
Other Job Type	17,325,219	0.528784	0.49917	0	1

Notes: Data are taken from SSA and DMDC records for the years 2001-2012. National Guard, Reserve troops, and observations with missing characteristics are omitted from the totals.

Table 2: The Effect of Deployment to Iraq or Afghanistan on Death

	(1)	(2)	(3)	(4)
Deployment	.0009649***	0.0007624***	0.0004763***	0.0004795***
	(7.1e-05)	(7.26e-05)	(5.66e-05)	(6.45e-05)
Control Variables?	No	Yes	No	Yes
Unit and Time Fixed Effects?	No	No	Yes	Yes
Observations	16,682,084	11,702,415	16,682,084	11,702,415

Notes: ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are clustered at the unit (battalion) level. Control variables include married, number of dependents, AFQT percentile, officer, age, gender, race, ethnicity, education, and job type. Time and unit fixed effects include year and battalion dummy variables. The linear probability model shown in the table has the primary outcome variable ($Fatality_{it}$) = 1 if service member i is killed in year t and 0 otherwise.

Table 3: The Effect of Deployment to Iraq or Afghanistan on Death by Service Type

	Army				Air Force			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Deployment	0.00106***	0.00101***	0.000608***	0.000657***	0.000193	-0.000044	1.7e-06	-7.43e-05
	(7.92e-05)	(8.8e-05)	(7.51e-05)	(8.49e-05)	(5.81e-05)	(6.45e-05)	(6.13e-05)	(6.73e-05)
Control Variables?	No	Yes	No	Yes	No	Yes	No	Yes
Unit and Time Fixed Effects?	No	No	Yes	Yes	No	No	Yes	Yes
Observations	6,147,411	4,379,534	6,147,411	4,379,534	3,860,794	2,750,476	3,860,794	2,750,476

	Navy				Marines			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Deployment	0.000414***	0.0003621**	0.0003157**	0.00037**	0.00084***	0.0006275***	0.00038***	0.00036**
	(0.0001573)	(0.0001514)	(0.0001449)	(0.000153)	(0.000194)	(0.0001526)	(0.000127)	(0.000144)
Control Variables?	No	Yes	No	Yes	No	Yes	No	Yes
Unit and Time Fixed Effects?	No	No	Yes	Yes	No	No	Yes	Yes
Observations	4,304,817	2,787,884	4,304,817	2,787,884	2,369,062	1,784,521	2,369,062	1,784,521

Notes: ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are clustered at the unit (battalion) level. Control variables include married, number of dependents, AFQT percentile, officer, age, gender, race, ethnicity, education, and job type. Time and unit fixed effects include year and battalion dummy variables. The linear probability model shown has the outcome variable ($Fatality_{it}$) take a value of 1 if soldier i is killed in year t and zero otherwise.

Table 4: The Effect of Deployment to Iraq or Afghanistan on Death by Job Type

	Combat Job				Support Job			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Deployment	0.00234***	0.00231***	0.00179***	0.0018***	0.00069***	0.00063***	0.00028***	0.0003***
	(0.00014)	(0.000151)	(0.000151)	(0.000156)	(0.00011)	(0.000129)	(9.8e-05)	(0.000115)
Control Variables?	No	Yes	No	Yes	No	Yes	No	Yes
Unit and Time Fixed Effects?	No	No	Yes	Yes	No	No	Yes	Yes
Observations	1,899,095	1,617,016	1,899,095	1,617,016	1,888,490	1,402,042	1,888,490	1,402,042

	Service Job				Other Job			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Deployment	0.00021***	0.00013**	1.98e-06	-2.23e-05	0.000338***	0.00009*	-6.93e-06	-1.20e-05**
	(5.12e-05)	(6.08e-05)	(5.13e-05)	(6.14e-05)	0.00045	(4.98e-05)	(4.47e-05)	(5.49e-05)
Control Variables?	No	Yes	No	Yes	No	Yes	No	Yes
Unit and Time Fixed Effects?	No	No	Yes	Yes	No	No	Yes	Yes
Observations	4,221,876	3,022,134	4,221,876	3,022,134	9,297,753	6,065,891	9,297,753	6,065,891

Notes: ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Standard errors are clustered at the unit (battalion) level. Control variables include married, number of dependents, AFQT percentile, officer, age, gender, race, ethnicity, education, and job type. Time and unit fixed effects include year and battalion dummy variables. The linear probability model shown above has the outcome $Fatality_{it}$ = 1 if the service member i is killed in year t and = 0 otherwise.